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Effects of ASEAN Transport Connectivity Enhancement[1]

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Abstract

There is a recognition that trade costs along domestic and international supply chains can be significantly reduced by improving the logistics performance in each mode of transport involved in various chain transactions. These improvements may be conveniently facilitated by the optimisation of the transitioning strategies from unimodal to multimodal (or combined) transport services. In this context, we examine here the status of current multimodal connectivity in freight transport practiced in the ASEAN region. We have focussed on the potential economic impacts of enhancing the levels of supply chain multimodal connectivity on the emerging economies of this region.

Our methodology has two stages. First, we estimated a 'multimodal transport index' for ASEAN economies, using available data on performance indicators for maritime, air and land transport, combined with indicators of current logistics competence. Second, the Global Trade Analysis Project (GTAP) economy-wide model is used to estimate the economic impacts of ongoing transport connectivity enhancements in the ASEAN region, focussing on the emerging ASEAN members such as Cambodia, the Lao PDR, Myanmar and Viet Nam. It is important to note in this respect that the 10 ASEAN member economies are heterogeneous in nature in terms of economic growth and development. There are, for example, the more advanced economies such as Singapore and Malaysia, which contrast with the four emerging economies in the region.

Our analysis of logistics performance in the ASEAN economies shows that (i) Singapore leads in performance indicators related to maritime transport, road density and logistics, (ii) Indonesia leads in primary airports and secondary airports, while (iii) Viet Nam has recorded the highest score in rail density. In addition, with respect to the performance indicators for maritime, primary airports, secondary airports and road density, there is a wide gap between the regional leader and most of

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the other ASEAN member economies, whilst our analysis of the logistics competence indicator shows moderately good performance in all of the ASEAN economies.

Of particular interest to this investigation, is our analysis of the estimated multimodal transport index which indicates that, although Singapore appears to be leading in overall multimodal transport performance, Indonesia's economy has drawn almost level. Their performance is followed closely by Thailand, Viet Nam and Malaysia. The Philippines and Myanmar have modest, and similar levels of multimodal transport performance, whilst at the other end of the spectrum, the Lao PDR, Cambodia and Brunei have relatively low levels of multimodal transport performance.

The economy-wide analysis shows that all else being equal, a 1.0 per cent improvement in factor productivity of the transport services in ASEAN will likely raise the real GDP in Cambodia, the Lao PDR, Myanmar and Viet Nam by 0.26, 0.15, 0.12 and 0.09 per cent respectively. Furthermore, it is estimated that a 1.0 per cent improvement in factor productivity of the transport services will increase consumer welfare in Cambodia, the Lao PDR, Myanmar and Viet Nam by US$ 28.9 million, US$ 11.7 million, US$ 73.5 million, and US$ 168.6 million respectively.

Key words: ASEAN, transportation, productivity gains, economy-wide modelling.

Introduction

It is generally accepted that, in order to improve the welfare of their citizens in the long term, governments must continually strive to strengthen their national economy. In the case of many developing countries, this is often a matter of enhancing domestic production and, simultaneously, facilitating uninterrupted and reliable access to foreign markets for agricultural and manufactured products. One key factor in this development is the stimulation of business investments which will open up domestic employment opportunities in a wide range of cognate areas. In parallel with this expansion of production potential, the provision of new export markets is a significant factor in the stimulation and growth of domestic production, and it is thus essential that a developing country builds a reliable and efficient export trade capacity to a wide range of customers. Of particular interest to this discussion is that the exporting country, in order to facilitate these international trade and business investments, needs to take measures to minimise trade costs whilst assuring delivery of materials in a timely and secure manner across all facets of its supply chain activities.

These trading costs, which come particularly as a result of transporting goods across national boundaries, are a significant and unavoidable financial impost on an exporting and/or importing country. Thus, in terms of maintaining a competitive edge in the face of competition from providers of similar products, there are critical time delay considerations which inevitably arise in the movements of manufactured and harvested material. The latter issue is significantly compounded if the materials are sensitive to external environmental conditions, or are subject to security and/or legal concerns.

We assert here that, in terms of the efficiency of the relevant supply chain mechanisms, such trade costs and related concerns could be reduced in a practical manner by improving the logistics performance in each mode of transport involved in the transaction. In particular, this improvement can be in the optimisation of the transitioning strategies from unimodal to multimodal (or combined) transport services. In many fields of commerce, there is already evidence of examples of significant savings in trading costs and delivery times arising from the creation and improvement of multimodal connectivity (Amber Coast Logistics, 2011), as well as from strategic sharing of services and equipment which are not under continuous requirement by a single mode.

In the context of this discussion, the term 'multimodal transport planning' refers to planning that involves requisitioning various modes of transport and ensuring seamless connections amongst available transport modes (Litman, 2017). Indeed, it has been observed that research in the area of multimodal transportation planning has accelerated during the last decade (Steadie Seifi et al., 2014), and this increasing interest in multimodal transport planning demonstrates a rising awareness of the critical importance of multimodal connectivity.

There have been a number of recent studies of relevance to this current investigation, but, as a developing area, these studies are somewhat scattered across the literature. They are, nevertheless, important indications of the growing interest in this area. For example, the concept of 'connectivity' between trading economies has been studied within a single mode (see Arvis and Shepherd, 2013) as well as between modes within a single economy (see Shepherd et al., 2011). Of even greater relevance to this current work, we note that multimodal connectivity assessments have mainly been conducted in relation to passenger transport (Litman, 2017; OECD, 2016; Krul et al., 2010). It is of concern that similar studies in relation to freight transport are not so common.

Notwithstanding this paucity of reported research, we note that the Asia-Pacific Economic Cooperation (APEC) group has completed a detailed study on the economic impact of multimodal connectivity in the APEC region (APEC, 2010). For each of the 19 APEC member economies analysed, the study details (i) the changes which have occurred in the time period 2005 to 2010, (ii) the relative positions with regard to maritime, air and land transport, (iii) a perspective on general logistic competence, and (iv) an aggregated multimodal transport indicator. In addition, an estimate of the correlation between exports and multimodal transport performance has been generated using a Gravity Model of Bilateral Trade (see Shepherd et al., 2011).

The notion of setting metrics for multimodal transport connectivity is a complex concept, and involves both the recording of the quality and quantity of existing infrastructure together with the private sector's ability to coordinate complex inter-modal linkages. In this respect, this study attempts to capture a number of relevant metrics related to multimodal activity, by including information appropriate to land, air and sea transport.

The Scope of the Study

This study will examine the following questions:

- What is the current situation in relation to multimodal connectivity in freight transport in the member economies of the ASEAN region?
- What are the potential economic impacts of increasing multimodal connectivity on the economies of the ASEAN region, in terms of economic growth?
- What are the perceived barriers to improving multimodal connectivity in freight transport within the ASEAN region?

The following approaches have been used to address the above questions. First, a composite multimodal transport index has been calculated to describe the present situation in relation to multimodal freight transport connectivity. Second, several hypothetical productivity improvement scenarios in multimodal transport using the GTAP model have been undertaken to assess the potential economic impacts. Third, a qualitative assessment of the barriers to improving multimodal connectivity is presented.

Current Status of Multimodal Connectivity in the ASEAN Region

An optimal combination of modes is necessary for achieving efficiencies in transporting traded goods. It is clear that the optimal choice of modal mix should be based on the availability and the quality of various transport modes, the details of the routes and infrastructure, as well as considerations of time, costs and risks involved, particularly for sensitive goods (e.g. perishables).

In order to reap the benefits of improving multimodal connectivity, an economy needs to have a mix of modes of freight transport of high quality, a well maintained infrastructure with efficient services and systems, and efficient inter-modal facilities. In this context, the performance of the available freight transport modes and inter-modal facilities within a framework of the supply chain, using both quantitative and qualitative measures, are exemplified by the following discussion for economies within the ASEAN region.

The 10 economies of the ASEAN region, and the abbreviations used for each of them in this paper, are as follows: Brunei (BRN); Cambodia (CAM); Indonesia (INS); Lao PDR (LAO); Malaysia (MAS); Myanmar (MYN); Philippines (PHL); Singapore (SIN); Thailand (THA); and Viet Nam (VNM). It is important to recognise that ASEAN economies are heterogeneous in nature in term of economic growth and development. At one end of the region's spectrum, there are more advanced economies such as Singapore and Malaysia; at the other there are emerging and rapidly growing economies such as Cambodia, Lao PDR, Myanmar and Viet Nam.

Transport performance in the ASEAN region

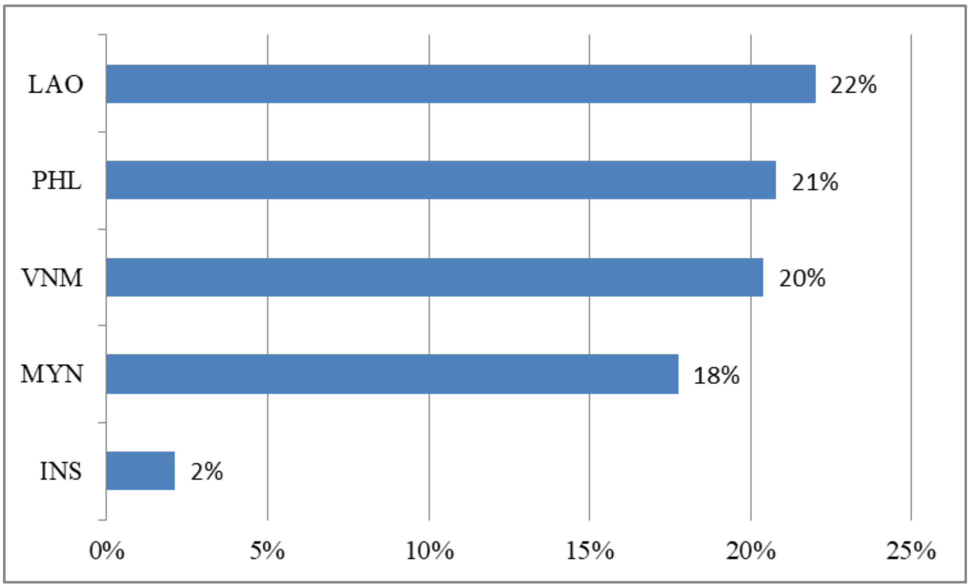
In discussing the transport performance of the ASEAN region, we have used data and information from the 'Logistics Performance Survey', conducted annually by the World Bank since 2007 (see https://lpi.worldbank.org), on private sector perceptions of supply chain performance and the perceived bottlenecks. The survey responses given by logistics professionals around the world, along six core dimensions, are aggregated into a single, comprehensive index, the Logistics Performance Index (LPI). The six core dimensions are as follows: efficiency of customs clearance processes; quality of trade and transport related infrastructure; ease of arranging competitively priced international shipments; competence and quality of logistics services; ability to track and trace consignments; and the frequency with which shipments reach the consignee within the scheduled time.

The main objective of the LPI index is to measure the efficiency of logistics supply chains based on survey feedback from industry. Its aim is to help countries identify the challenges and opportunities in their trade logistics by measuring the logistics' 'friendliness'. Based on a worldwide survey of operators on the ground - such as global freight forwarders and express carriers - the LPI measures the logistics friendliness of 155 countries. The LPI consists of both qualitative and quantitative measures and helps build profiles of logistics friendliness for these countries. The publication of the LPI led to a global discussion on the importance of logistics in world economic growth. It highlighted the need to implement relevant policies to improve future logistics performance. By comparing the LPI index over time, the considerable value of trade facilitation policies can be understood. Furthermore, the index and its components can help countries (governments and industry) to get to know their business partners more closely and implement any possible adjustments that could affect their competitiveness.

According to the latest LPI survey by the World Bank (Arvis et al., 2018), the infrastructure core dimension has improved since 2007 in five of the 10 ASEAN economies (Figure 1). The declines in the infrastructure dimension of the LPI score over the years were evident in Brunei (down 11 per cent since 2016, when Brunei entered the survey), Cambodia (down 7 per cent), Malaysia and Singapore (both down 5 per cent) and Thailand (down 1 per cent). But, it is important to recognise that the LPI scores were already high for Singapore, Malaysia and Thailand (see Table 7).

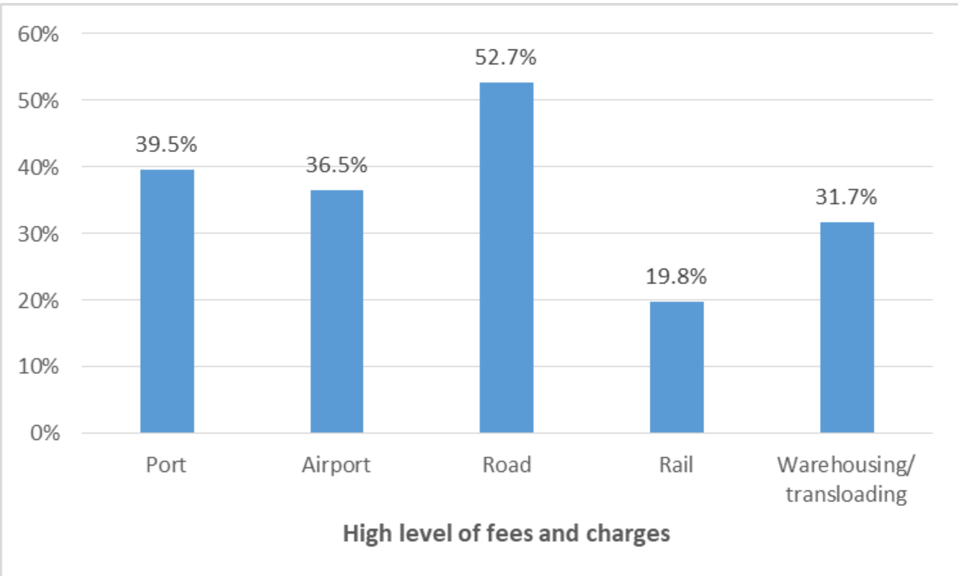
The most recent data on each mode of transport and inter-modal connections (see World Bank, 2018a) are summarised and presented as simple averages across the ASEAN economies in Figures 2, 3 and 4. These figures show that road transport has the highest level of dissatisfaction with respect to fees and charges (see Figure 2), while rail transport has the highest level of dissatisfaction in terms of quality of infrastructure (see Figure 3). Rail transport has also the highest level of dissatisfaction in relation to the competence and quality of service (see Figure 4).

Figure 1. Logistics infrastructure improvement (in 2018 compared to 2007 levels in % terms) in five ASEAN economies



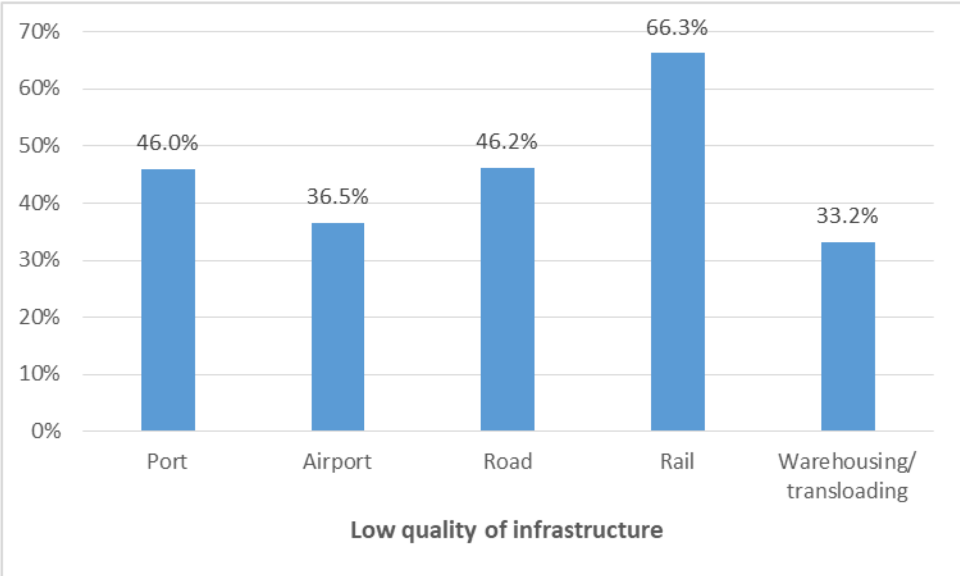
Source: based on Arvis et al. (2007, 2018)

Figure 2. Percentage of respondents answering that "Fees and charges are high/very high"



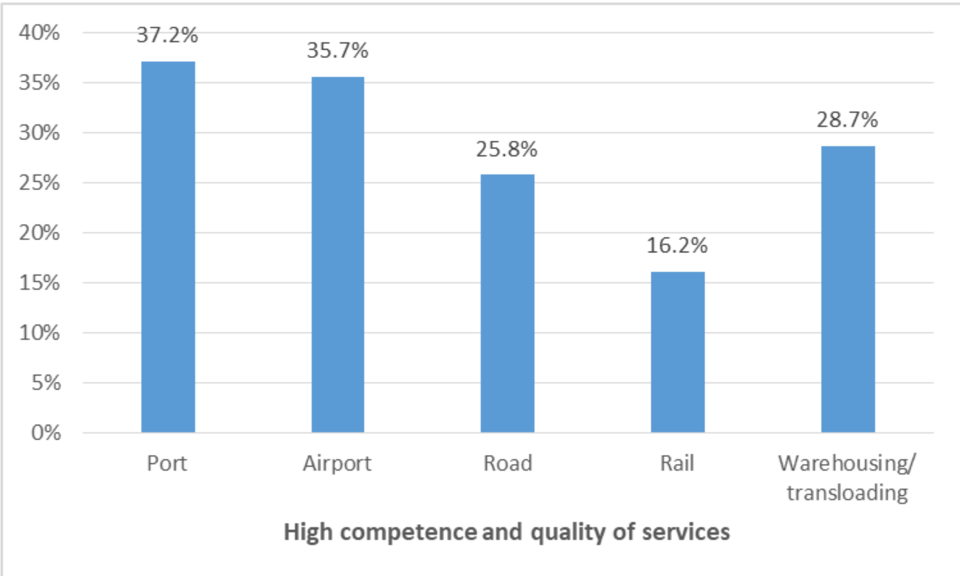
Source: World Bank (2018a)

Figure 3. Percentage of respondents answering that "Quality of infrastructure is low/very low"



Source: World Bank (2018a)

Figure 4. Percentage of respondents answering that "Competence and quality of services is high/very high"



Source: World Bank (2018a)

Maritime transport

How well an economy is connected to global shipping networks, is addressed by the Liner Shipping Connectivity Index (LSCI) developed by the United Nations Conference on Trade and Development (UNCTAD). The LSCI aims at capturing the level of integration into the existing liner shipping network by measuring liner shipping connectivity. It can be calculated at the country and at the port level. LSCI can be considered a proxy of the accessibility to global trade. The higher the index, the easier it is to access a high capacity and frequency of global maritime freight transport system and thus effectively participate in international trade (UNCTAD, 2018).

Therefore, LSCI can be jointly considered as a measure of connectivity to maritime shipping and as a measure of trade facilitation. It reflects the strategies of container shipping lines seeking to maximize revenue through market coverage. The index is computed based on several key components of the maritime transport sector: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports. As of 2017, Singapore, Malaysia and Viet Nam are among the top three performers across the ASEAN region, followed by Thailand and Indonesia who are equal in shipping connectivity (Table 1). The LSCI has improved since 2004 in all nine economies for which data are available, while there has been a slight decline from 2016 to 2017 in all the economies except Indonesia and Myanmar.

Table 1. Liner Shipping Connectivity Index (LSCI) in ASEAN economies, 2004 to 2017

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Brunei	4	3	3	4	4	4	5	5	4	5	4	5	9	7
Cambodia	4	3	3	3	3	5	5	5	3	5	6	7	9	8
Indonesia	26	29	26	26	25	26	26	26	26	27	28	27	30	41
Lao PDR [a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malaysia	63	65	69	82	78	81	88	91	100	98	104	111	102	98
Myanmar	3	2	3	3	4	4	4	3	4	6	6	6	9	14
Philippines	15	16	16	18	30	16	15	19	17	18	20	18	28	25
Singapore	82	84	86	88	94	99	104	105	113	107	113	117	120	115
Thailand	31	32	34	35	36	37	44	37	38	38	45	44	47	41
Viet Nam	13	14	15	18	19	26	31	50	49	43	46	46	62	60

Note: Index (Maximum for an economy in 2004=100). [a] Lao PDR does not have a maritime border.
Source: UNCTAD (2018)

Based on the 2018 survey of logistics professionals in each of the six ASEAN economies surveyed, port charges are considered to be ‘high’ by the highest proportion of respondents in Indonesia, while Singapore, Malaysia and Philippines had the lowest proportion (Figure 5). The quality of port infrastructure is considered low by the highest proportion in Indonesia, followed by the Philippines. The highest proportion of respondents in Singapore perceives the competence and quality of maritime transport services to be high, followed by Malaysia.

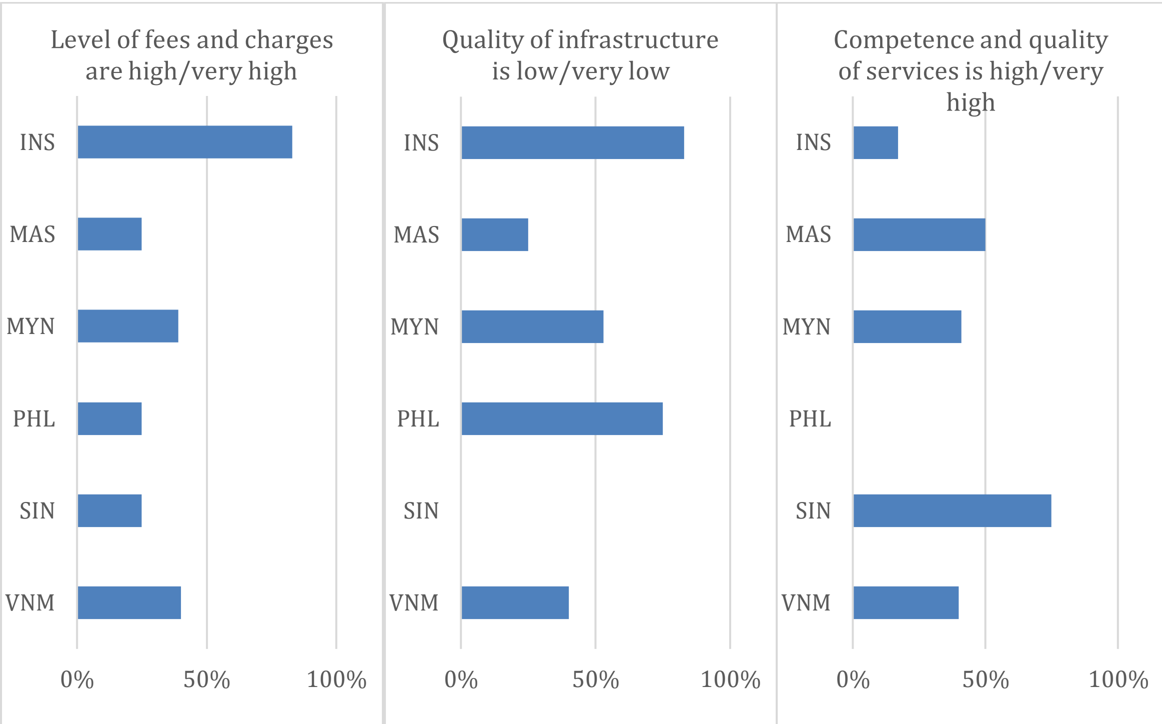
Inland water transport

Recent data on inland waterways in ASEAN economies are not readily available from a common, comparable source. The CIA World Factbook (CIA, 2017), which provides internationally comparable data, shows that Viet Nam has the largest network of inland waterways, followed by Indonesia and Myanmar (Table 2). Qualitative data that is comparable between ASEAN economies are not available on inland water transport.

Air transport

According to CIA (2017), there is a total of 1,311 airports across the ASEAN region (Table 3). Indonesia has the largest number of airports, followed by Philippines, Malaysia and Thailand. Brunei has only one paved airport, Singapore has all its airports with paved runways, and Viet Nam and Thailand have the next largest proportion of paved runways. Of a country’s total number of airports, Singapore has the greatest proportion of its airports as primary airports, followed by Viet Nam and Myanmar.

Figure 5. Maritime transport (percentage of respondents agreeing with the three propositions)



Source: World Bank (2018a)

Table 2. Inland waterway statistics for ASEAN economies

	Year	Total length (km)
Brunei	2012	209
Cambodia	2012	3,700
Indonesia	2011	21,579
Lao PDR	2012	4,600
Malaysia	2011	7,200
Myanmar	2011	12,800
Philippines	2011	3,219
Singapore		
Thailand	2011	4,000
Viet Nam	2011	47,130

Source: CIA (2017)

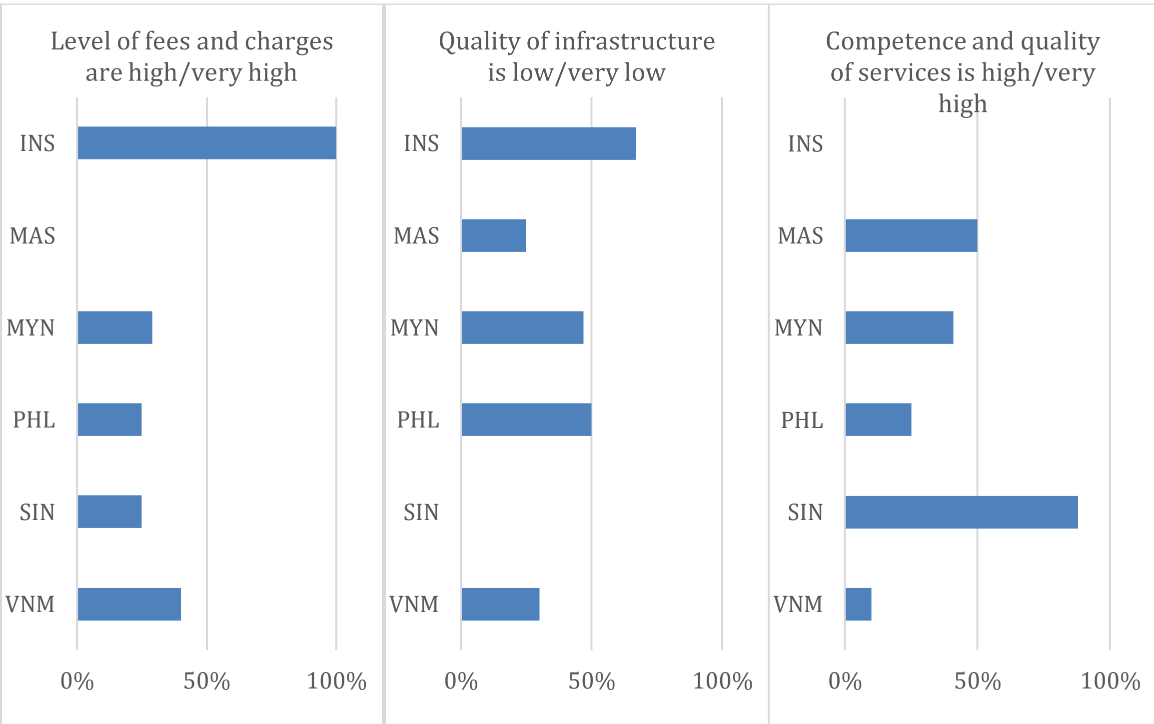
Based on the survey of domestic logistics professionals from the ASEAN economies, airport fees and charges are perceived to be high by all of the respondents in Indonesia (Figure 6). Meanwhile, Indonesia also tops the proportion of respondents dissatisfied with the quality of air transport infrastructure, followed by Philippines and Myanmar. The perceived satisfaction with the competence and the quality of air transport services is highest in Singapore, followed by Malaysia and Myanmar.

Table 3. Air transport infrastructure in ASEAN economies

	Total number of airports	Airports with paved runways	Primary airports	Secondary airports
Brunei	1	1	1	
Cambodia	16	6	3	2
Indonesia	673	186	26	51
Lao PDR	41	8	3	4
Malaysia	114	39	16	7
Myanmar	64	36	23	12
Philippines	247	89	12	33
Singapore	9	9	4	3
Thailand	101	63	20	23
Viet Nam	45	38	16	13

Source: CIA (2017)

Figure 6. Air transport (percentage of respondents agreeing with the three propositions)



Source: World Bank (2018a)

Road transport

Most of the ASEAN economies, except Philippines and Singapore, are connected with another country by land, allowing alternative modes of freight transport. Economies that share borders are (see CIA, 2017) as follows: Brunei – 266 km with Malaysia; Cambodia – 2,530 km with Lao PDR, Thailand and Viet Nam; Indonesia – 2,958 km with Malaysia, Papua New Guinea and Timor-Leste; Lao PDR – 5,274 km with Cambodia, China, Myanmar, Thailand and Viet Nam; Malaysia – 2,742 km with Brunei, Indonesia and Thailand; Myanmar – 6,522 km with Bangladesh, China, India, Lao PDR and Thailand; Thailand – 5,673 km with Cambodia, Lao PDR, Malaysia and Myanmar; and Viet Nam –

Table 4. Road statistics for ASEAN economies

	Year of data	Total roadways (km)	Percentage of road paved	Road service (km of road per 1,000 people)	Road density (km of road per 1,000 sq km of land)
Brunei	2010	3,029	80	7.07	574.76
Cambodia	2010	44,709	8	2.79	253.28
Indonesia	2011	496,607	57	1.88	274.13
Lao PDR	2009	39,586	14	5.77	171.52
Malaysia	2010	144,403	80	4.57	439.52
Myanmar	2010	34,377		0.64	52.64
Philippines	2014	216,387	28	2.06	725.72
Singapore	2012	3,425	100	0.61	4,830.75
Thailand	2006	180,053		2.61	352.43
Viet Nam	2013	195,468	76	2.05	630.40

Source: based on CIA (2017)

4,616 km with Cambodia, China and Lao PDR. Singapore and Malaysia are connected by a causeway, paving the way for alternative modes of freight transport.

The key characteristics of the road network in ASEAN economies are shown in Table 4. Indonesia has the largest road network across ASEAN, followed by Philippines, Viet Nam, Thailand and Malaysia. Singapore has all its roads paved and Brunei, Malaysia and Viet Nam follow in the proportion of the road network paved. Singapore possesses the lowest length of road network per 1,000 people, but the highest per 1,000 sq. km of land.

According to the survey of domestic logistics professionals (see World Bank, 2018a), more than half of the respondents in Indonesia, Viet Nam and Myanmar perceive the road transport charges to be high and the quality of road infrastructure to be low (Figure 7). Only a very low proportion of the respondents in all ASEAN economies except Singapore, perceive the competence and quality of road transport services to be high.

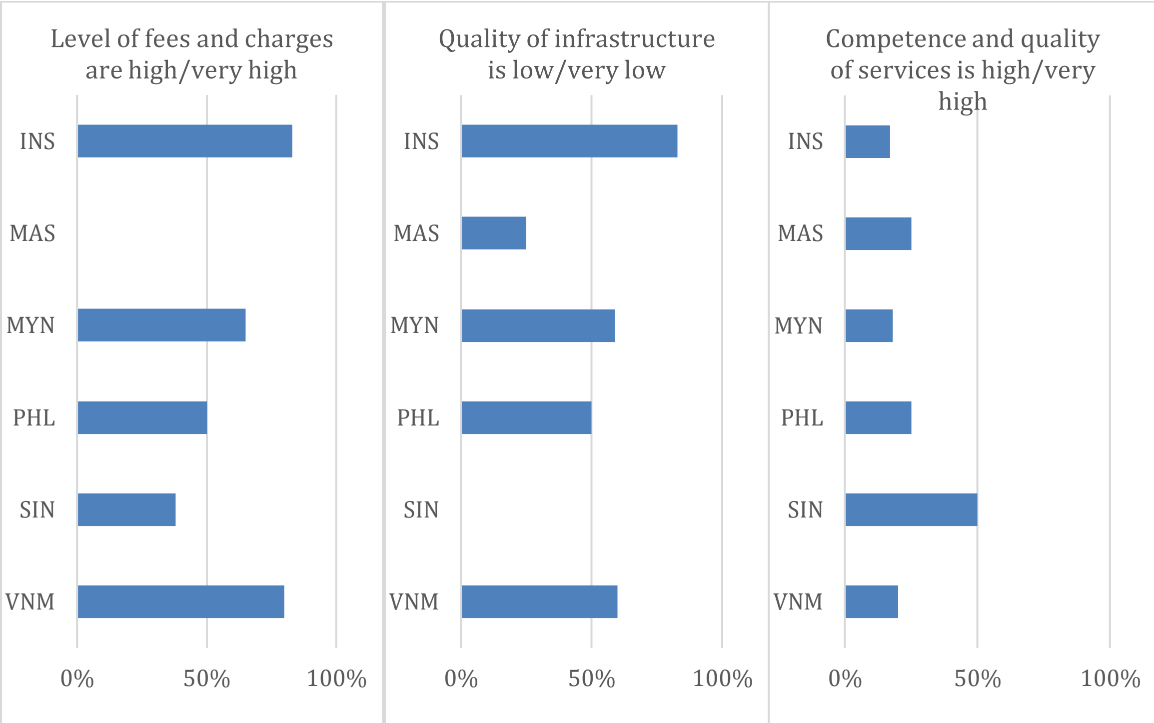
Rail transport

Indonesia has the longest rail network among the ASEAN economies, followed by Myanmar, Thailand, Viet Nam and Malaysia (Table 5).

Although eight of the 10 ASEAN economies share borders with another economy, international rail links are greatly constrained by the different track gauge systems adopted by adjoining countries, when constructing rail systems. Information regarding these gauges is shown in Table 6.

According to the survey of domestic logistics professionals, more than half of the respondents in Viet Nam perceive rail transport charges to be high (Figure 8). In addition, all of the respondents from Viet Nam and the Philippines, and more than half of those in Indonesia and Myanmar, perceive the rail infrastructure to be of low quality. It is clear that the majority of rail users in some economies did not feel satisfied with the competence and quality of rail transport services (see Figure 8).

Figure 7. Road transport (percentage of respondents agreeing with the three propositions)



Source: World Bank (2018a)

Table 5. Rail line statistics for ASEAN economies

	Year of data	Total rail lines (km)
Brunei		
Cambodia	2014	642
Indonesia	2014	8,159
Lao PDR		
Malaysia	2014	1,851
Myanmar	2008	5,031
Philippines	2015	995
Singapore		
Thailand	2017	4,127
Viet Nam	2014	2,600

Source: CIA (2017)

Inter-modal facilities

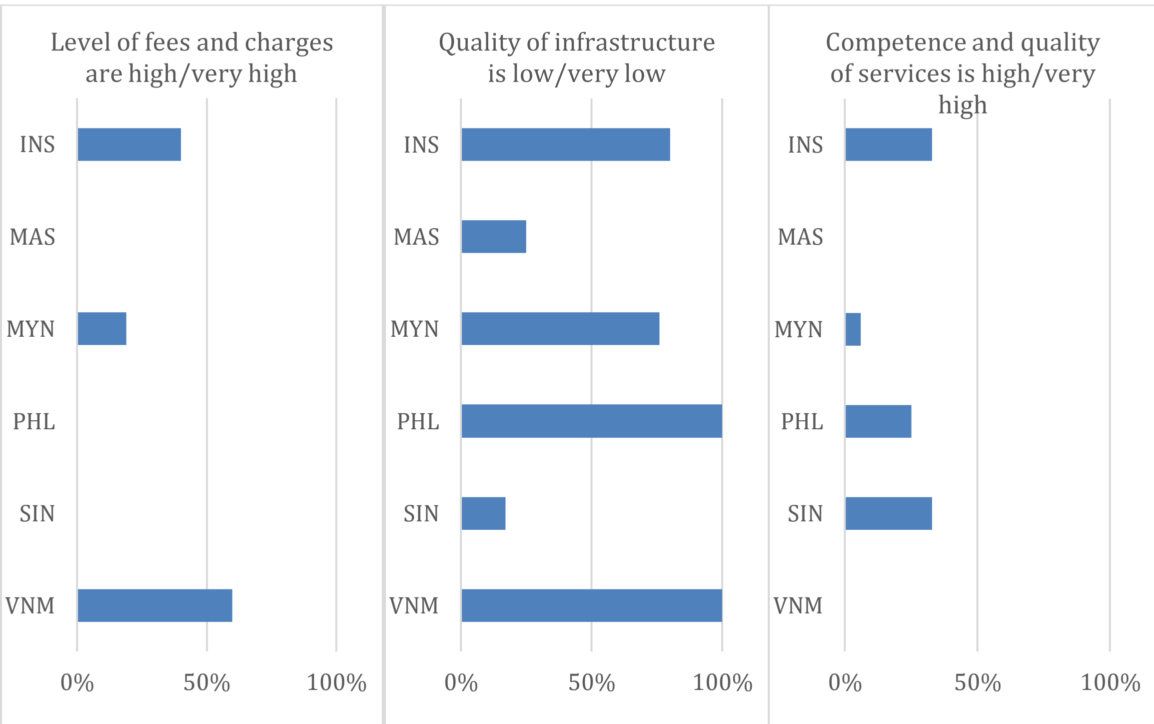
To ensure efficient transport of traded goods using more than a single mode of transport, there is a critical need for efficient warehousing and transloading activities. It appears that, at present, this is not provided for in many ASEAN countries. The perception of warehousing and transloading charges, by half of the domestic logistics professionals surveyed in Indonesia and Philippines, is that they are high (Figure 9), and the quality of warehousing and transloading infrastructure is perceived to be low by at least half of the respondents in both Viet Nam and the Philippines. However, the competence and quality of warehousing and transloading services is considered high by at least half of the respondents in both Singapore and Malaysia. These figures suggest that there are challenges in the ASEAN region with issues related to warehousing and transloading services.

Table 6. Rail gauges in ASEAN economies

	Railways broad gauge (km)	Railways standard gauge (km)	Railways narrow gauge (km)
Brunei			
Cambodia			642 km 1.000-m gauge
Indonesia			8,159 km 1.067-m gauge (565 km electrified)
Lao PDR			
Malaysia		59 km 1.435-m gauge (59 km electrified)	1,792 km 1.000-m gauge (339 km electrified)
Myanmar			5,031 km 1.000-m gauge
Philippines			995 km 1.067-m gauge (484 km are in operation)
Singapore			
Thailand		84 km 1.435-m gauge (84 km electrified)	4,043 km 1.000-m gauge
Viet Nam		178 km 1.435-m gauge; 253 km mixed gauge	2,169 km 1.000-m gauge

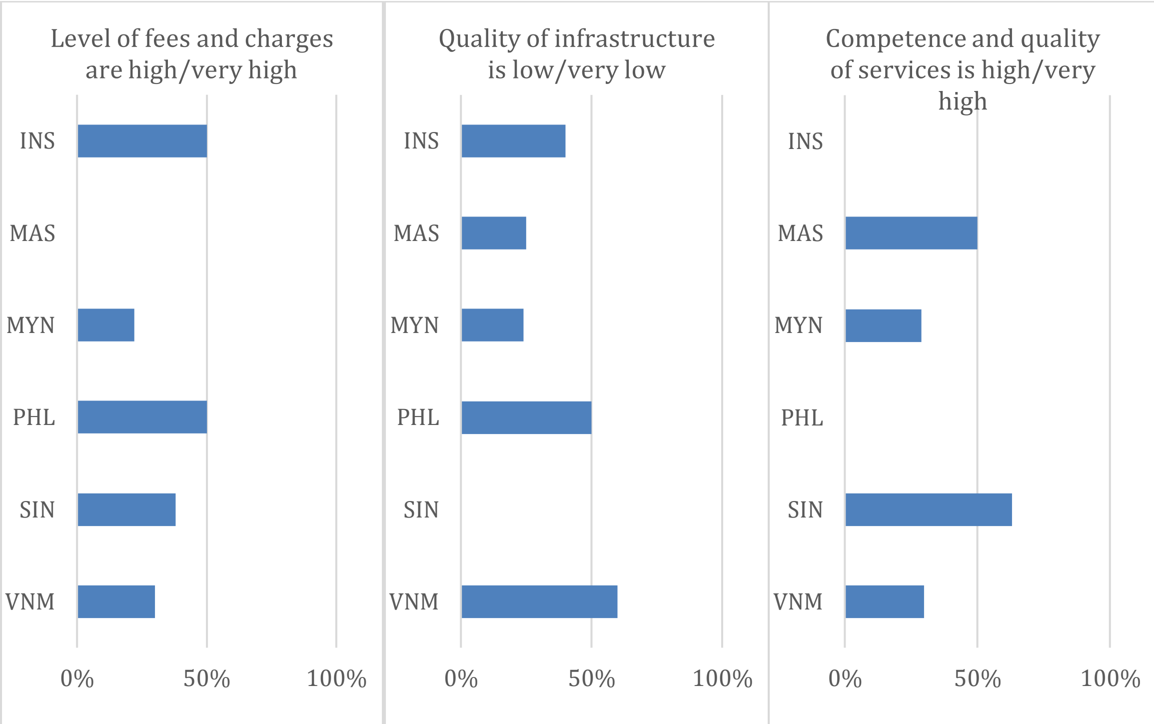
Source: CIA (2017)

Figure 8. Rail transport (percentage of respondents answering three propositions)



Source: World Bank (2018a)

Figure 9. Warehousing/Transloading (percentage of respondents agreeing with the three propositions)



Source: World Bank (2018a)

Logistics environment

The overall logistics environment plays a major role in the ability of the private sector to plan and organise complex logistics activities and to make the individual transport modes work together effectively. As earlier indicated, The World Bank's Logistics Performance Index (LPI) summarises the most important aspects of the logistics environment under six core dimensions using a five-point scale for assessing current performance. The ASEAN region in 2018, recorded an average score of 3.02, which is in the middle of the scale (Table 7). Individual countries which score higher than average are Singapore, having the highest LPI score of 4.0, followed by Thailand (3.41), Viet Nam (3.27), Malaysia (3.22) and Indonesia (3.15). In comparing the LPI scores between 2007 and 2018, it can be concluded that only three of the ASEAN economies, Viet Nam, Myanmar and Lao PDR, have considerably improved their logistics performance over that period.

Multimodal Connectivity in the ASEAN Region

Methodology for measuring multimodal connectivity: towards a 'Multimodal Transport Index'

An ideal method to measure multimodal connectivity in economies that are in transition from unimodal to a multimodal transport system, is to evaluate the progress in implementing the required reforms and changes. Since this transition process has only recently commenced in most of the ASEAN economies, the necessary data to make this evaluation are yet to become available. As a consequence, this study focuses on using relevant data that are readily available from domestic and international sources, which could be used as a proxy for an economy's ability to manage inter-modal connections along the supply chain. Performance indicators for maritime, air and land transport, as well as for logistics competence, were chosen from the data and analysis presented in previous sections.

Table 7. Logistics performance in ASEAN economies

	2007			2018		
	Lower bound	**LPI score**	**Upper bound**	**Lower bound**	**LPI score**	**Upper bound**
Brunei	-	-	-	2.51	**2.71**	2.91
Cambodia	2.38	**2.50**	2.62	2.38	**2.58**	2.78
Indonesia	2.88	**3.01**	3.14	2.85	**3.15**	3.45
Lao PDR	2.01	**2.25**	2.46	2.47	**2.70**	2.93
Malaysia	3.41	**3.48**	3.55	3.00	**3.22**	3.44
Myanmar	1.69	**1.86**	2.07	2.10	**2.30**	2.50
Philippines	2.54	**2.69**	2.84	2.73	**2.90**	3.07
Singapore	4.14	**4.19**	4.24	3.86	**4.00**	4.13
Thailand	3.21	**3.31**	3.41	3.29	**3.41**	3.53
Viet Nam	2.71	**2.89**	3.07	3.11	**3.27**	3.44
ASEAN average		**2.91**			**3.02**	

Source: Arvis, et al., (2007, 2018)

These performance indicators are presented for each ASEAN economy as a percentage of the score recorded by the regional leader for each indicator. This method of presenting the relative scores results in two important advantages. First, the focus of the evaluation would be centred on the regional best practice cases, and second, the data for all modes will be standardised within a single scale, facilitating comparisons across the indicators.

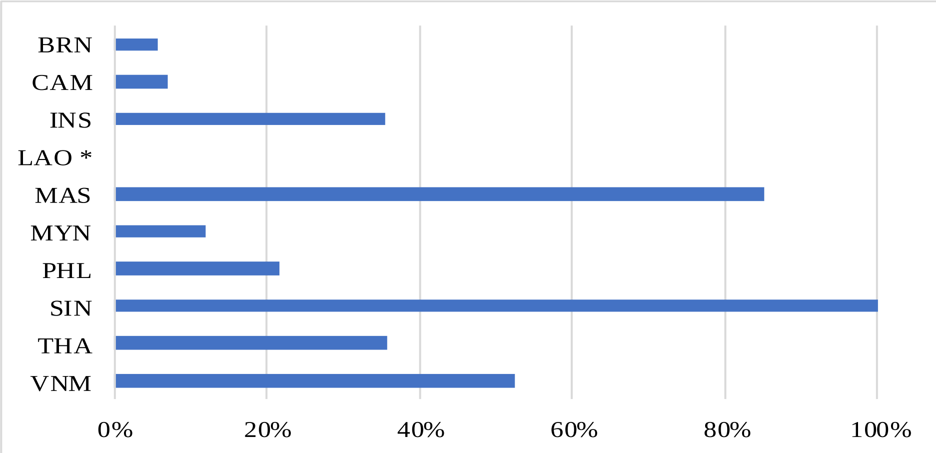
Analysis and discussion of Multimodal Transport Index

Available performance indicators are firstly presented for maritime, air and land transport, as well as for logistics competence, with the scores being relative to that of the regional leader for each indicator. Subsequently, an aggregated multimodal transport index is developed using the indicators above. This involved calculating the Z-scores of all six datasets: number of primary airports, number of secondary airports, road density, rail density, maritime index and logistics index.

For maritime transport, the LSCI developed by the UNCTAD is a useful indicator (see Figure 10). In LSCI, a variety of liner shipping indicators are combined into a single, broad-based index by averaging the relative scores calculated for each of the indicators. The LSCI takes five factors into account, namely, the number of ships, their container carrying capacity, maximum vessel size, number of services, and number of companies deploying container ships to and from an economy's ports (see UNCTAD, 2018). These factors include measures that could be considered as quantitative as well as qualitative.

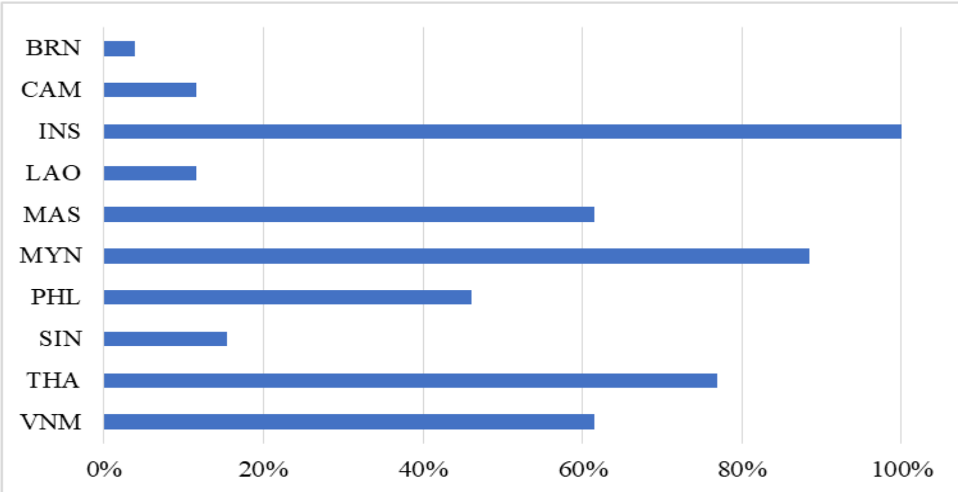
There is no indicator for air transport which can be considered to be equivalent to the LSCI. However, there are two sets of data that can be considered as proxy air transport indicators. The number of primary airports and the number of secondary airports in each ASEAN economy were sourced from the CIA World Factbook (see CIA, 2017). These two indicators are presented as relative scores across the ASEAN economies in Figures 11 and 12. They also provide an indication of the status of the air transport infrastructure.

Figure 10. Maritime transport indicator, as a percentage of the regional leader's score



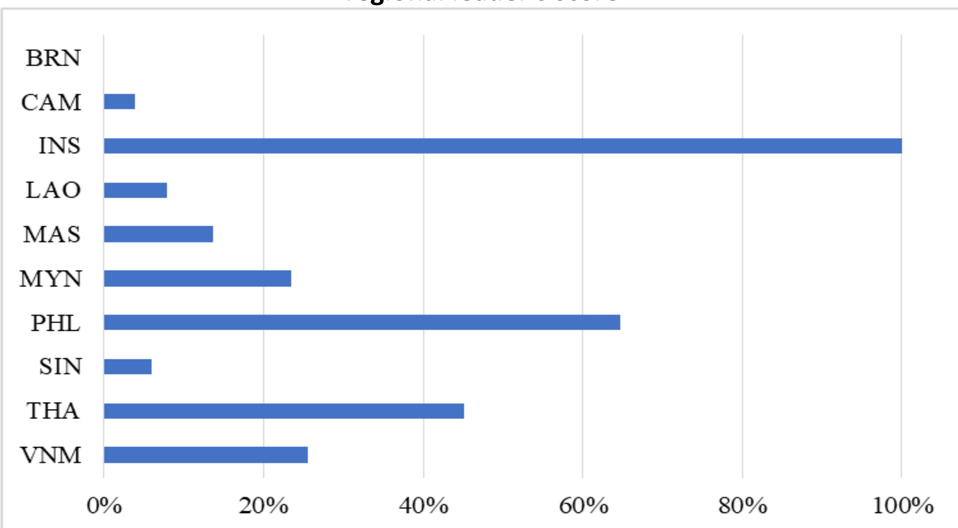
Source: UNCTAD (2018) * Lao PDR does not have a maritime border.

Figure 11. The number of primary airports as an air transport indicator, as a percentage of the regional leader's score



Source: based on CIA (2017)

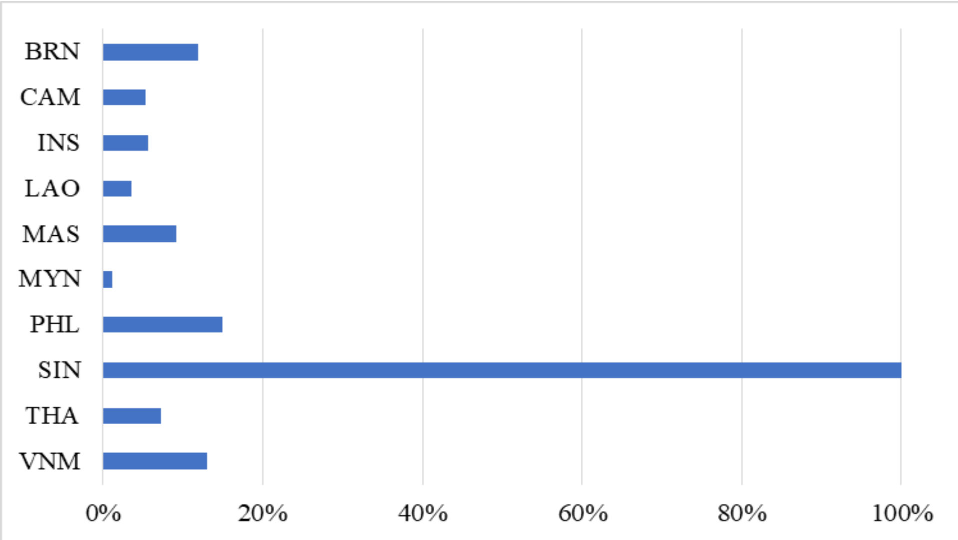
Figure 12. The number of secondary airports as an air transport indicator, as a percentage of the regional leader's score



Source: based on CIA (2017)

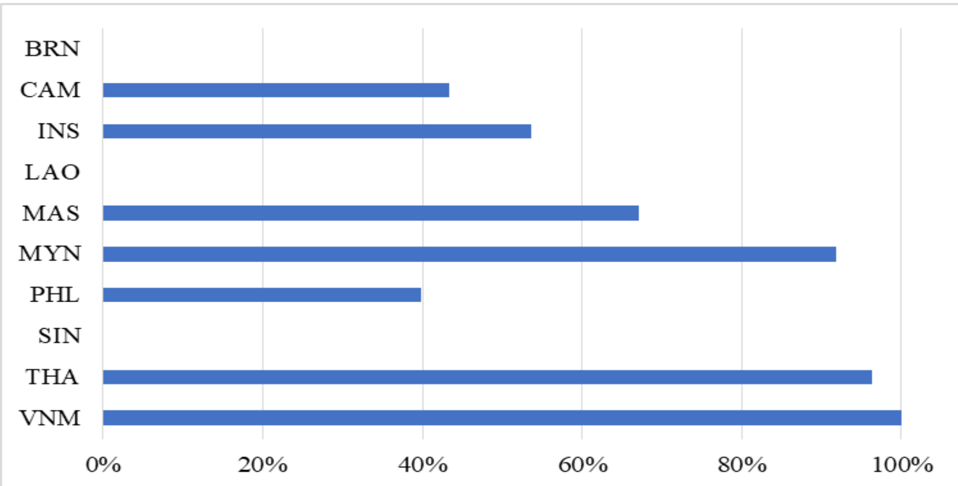
Transport of produced goods between factory, warehouse and port facilities requires efficient land transport within an economy, and international trade is often impossible to complete without having a strong land transport environment. It is thus clear that land transport is an important aspect of multimodal connectivity. To help provide a metric for this mode, the 'road network density' and the 'rail network density' have been used. Each density was calculated as km of road or rail per 1,000 sq. km of land. The total length of the road and rail network in an economy, were sourced from the CIA World Factbook (CIA, 2017), and the land area of an economy was sourced from World Bank (2018b). These two land transport indicators are presented as relative scores across the ASEAN economies, in Figures 13 and 14.

Figure 13. Road density as a land transport indicator, as a percentage of the regional leader's score



Source: based on CIA (2017) and World Bank (2018b)

Figure 14. Rail density as a land transport indicator, as a percentage of the regional leader's score

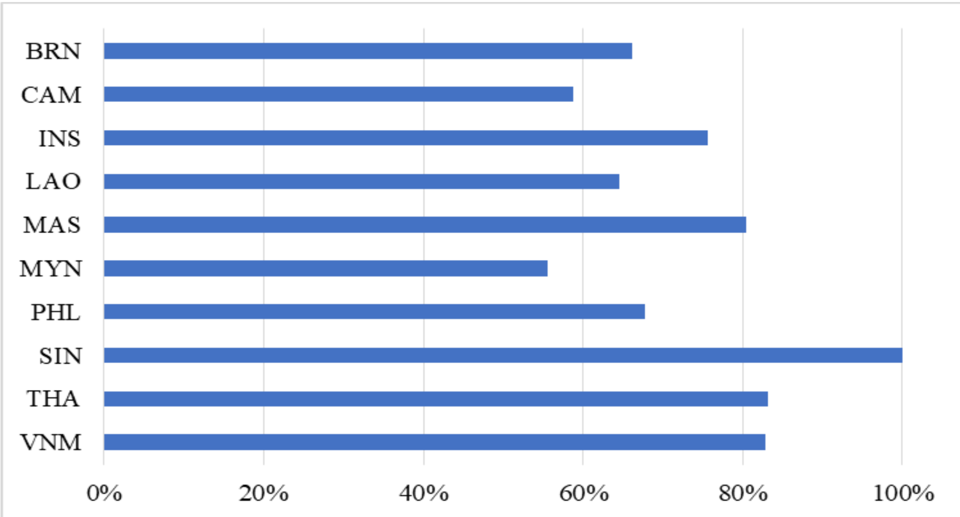


Source: based on CIA (2017) and World Bank (2018b)

Use of the density of road and rail networks, rather than the total length of land transport in an economy, removes the bias towards economies that are geographically large. This adjustment is important because some economies that are geographically small (e.g. Singapore) have very well-developed road or rail links.

Logistics environment is the final major dimension of multimodal transport connectivity considered here. Operators in logistics are responsible for coordinating complex cross-border transactions and a variety of transport modes, as well as ensuring necessary interchanges and trans-shipments. The most comprehensive dataset to measure the performance of an economy's logistics is the World Bank's Logistics Performance Index (LPI), which has been described previously. Out of the six dimensions of logistics performance of an economy that are captured in the LPI, the 'competence and quality of logistics services' dimension is used to measure an economy's ability to coordinate complex multimodal transactions (see Figure 15).

Figure 15. The 'Competence and Quality of Logistics Services' dimension of LPI, as a percentage of the regional leader's score



Source: World Bank (2018a)

It is apparent that Singapore leads in performance indicators related to maritime transport, road density and logistics while Indonesia leads in primary airports and secondary airports. Viet Nam has recorded the highest score in rail density. Compared to the indicators for maritime, primary airports, secondary airports and road density where there appears to be a wide gap between the regional leader and most of the other ASEAN economies, the logistics competence indicator shows relatively good performance in all of the ASEAN economies considered.

An aggregate index was estimated by combining all six performance indicators, to obtain an overall measure of multimodal transport connectivity across the region. The data available for each of the six indicators were standardised by calculating their Z-scores (see Box 1). These Z-scores were added up against each ASEAN economy, to arrive at a composite multimodal transport index across the economies. Since the Z-scores are based on a range from negative to positive numbers spread around an average of zero by definition, the estimated multimodal transport index is presented on a scale between zero and one (Figure 16). The economy having a score of "0.00" means that it has recorded the lowest index out of all 10 ASEAN economies under consideration. Similarly, the economy having a score of "1.00" means it has recorded the highest index.

Although Singapore appears to be leading in overall multimodal transport performance based on the estimated index, Indonesia has almost equalled the leading economy, followed closely by Thailand, Viet Nam and Malaysia, all having scores at or above 0.80. The Philippines and Myanmar have scored around 0.50 while Lao PDR, Cambodia and Brunei have scored below 0.20.

Box 1. Estimating the Composite Multimodal Transport Index

The objective of estimating a composite Multimodal Transport Index was to use the index as a proxy, to compare inter-modal connectivity and performance across the supply chain, between the ten economies of the ASEAN region. Six indicators were selected under four main aspects of freight transport connectivity. The four aspects considered were sea transport, air transport, land transport and logistics competence. The six indicators were selected on the basis of the availability of reliable data published by international sources.

The data for each of the six indicators were first converted to 'z scores' so that the data for indicators expressed in different units could be standardised into a single basis of relative scores. These z scores could then be aggregated by either simple averaging (or simple addition) or weighted averaging (Song et al., 2013). Simple averaging (or simple addition) is the most commonly used approach to creating a composite index, especially when the sample size is small.

In the approach adopted in our analysis, the composite index (C) is created by summing up z scores of the original variables:

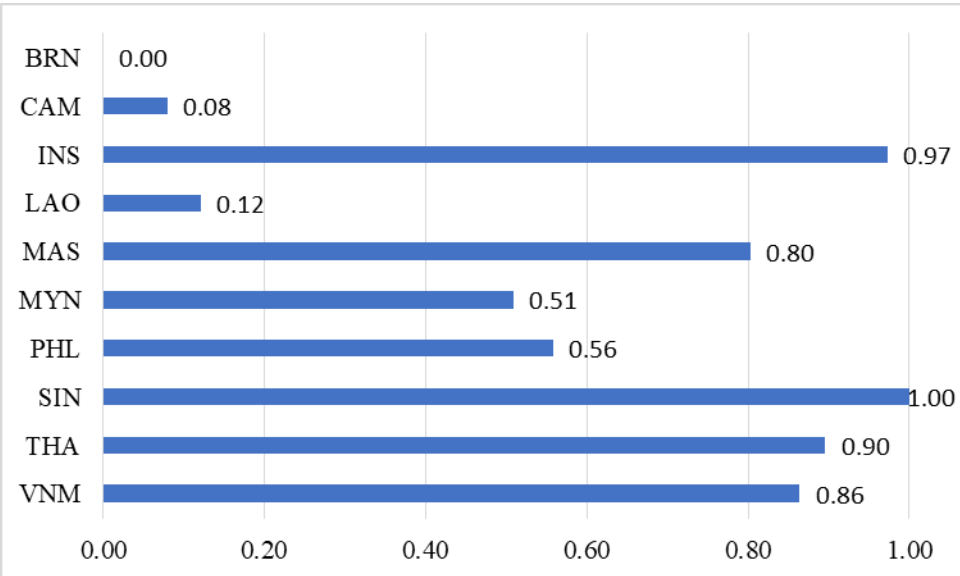
$C = z_1 + z_2 + \ldots\ldots z_n$,

where $z = (x - \bar{x}) / S_x$ – for each of the six indicators, and where

x is the value of each indicator across the 10 ASEAN countries, $\bar{x}$ is the mean of each indicator across the 10 ASEAN countries and S_x is the standard deviation of each indicator across each of the 10 ASEAN countries.

The Z scores have a mean of zero with a range from negative to positive numbers. As indicated earlier, the resulting composite index across the ten ASEAN economies was then presented as relative scores ranging from 0.0 to 1.00 (see Figure 16).

Figure 16. Multimodal transport index, on a scale between 0.00 and 1.00



Source: Authors' calculations

These measures of multimodal connectivity are based on performance outcomes, such as infrastructure quantity and quality. In interpreting these measures, it is important to note that government policy plays a major role in enhancing multimodal transport connectivity. In other words, in addition to supporting the construction and maintenance of infrastructure, an appropriate regulatory environment needs be created for the service providers to be able to perform efficiently. Policy makers have an important role in the functioning of all modes of transport, and in helping to build private sector capacity and to create a trade-friendly environment.

The analysis of the key issues in this paper is based on the premise that freight transport and related logistics services are of high importance in facilitating the mobility of products, ensuring their safety and speed as well as providing cost reductions when international trade among countries is growing. In this context the interpretation of the data and information provided earlier in this paper highlights the following, particularly, in relation to the emerging member economies of ASEAN.

First, the logistics infrastructure has improved since 2007 in Lao PDR, Philippines, Vietnam and Myanmar. However, efficient warehousing and transloading activities for freight are not the case in many ASEAN countries at present. This is a key challenge for efficient transport of traded goods using more than a single mode of transport.

Second, road transport in the ASEAN region has the highest level of dissatisfaction with respect to fees and charges while rail transport has the highest level of dissatisfaction in terms of the quality of infrastructure. In Indonesia, Viet Nam and Myanmar road transport charges are regarded to be relatively high and the quality of road infrastructure to be relatively low. Only a relatively small proportion of freight and related operators in most of the ASEAN economies (except for Singapore) regarded the competence and quality of road transport services to be high.

Third, rail transport has also the highest level of dissatisfaction in relation to the competence and quality of service. Rail infrastructure in Viet Nam, the Philippines, Indonesia and Myanmar are regarded to be of low quality. Also, the majority of the rail users in some ASEAN economies did not feel satisfied with the competence and quality of rail transport services.

Fourth, in general, maritime transport activities have improved in most of the ASEAN economies since 2004. However, port charges are considered to be relatively high in Indonesia, while Singapore, Malaysia and the Philippines had the relatively lowest port charges. The quality of port infrastructure is considered low in Indonesia, followed by the Philippines. On the other hand, the competence and quality of maritime transport services in Singapore is considered to be high, followed by Malaysia.

Finally, with respect to air transport of freight, the quality of air transport infrastructure is regarded to be relatively low in Indonesia, the Philippines and Myanmar. On the other hand, the competence and the quality of air transport services is regarded to be relatively high in Singapore, Malaysia and Myanmar.

Economy-wide Impacts of Better Transport Connectivity

Some of the ASEAN economies, such as Singapore, Malaysia and Thailand, offer multimodal operators an environment that can support the development of this sector, while it appears that most other countries are currently lagging behind in multimodal transport performance (Dullaert et al., 2012). It is evident from the analysis presented in previous sections that there is considerable scope for improving multimodal transport connectivity in most of the economies in the ASEAN region. In this respect, we note that Bizoi and Sipos (2014) have demonstrated the positive relationship between the Gross Domestic Product (GDP) and the logistics performance across different economies of the European Union. The approach used in their study highlights the potential impact of improving transport performance on the GDP of national economies.

Given this background, our methodology here involves an economy-wide analytical framework. We use the Global Trade Analysis Project (GTAP) model (Hertel, 1997) and the GTAP global database (see Appendix 1). Our computable general equilibrium framework provides a robust representation of the structure of the global and regional economies (including the ASEAN economies) and the transactions among economic agents.

In this analysis, we estimate the economy-wide impacts of ongoing transport connectivity enhancements in the ASEAN region particularly in the context of emerging and rapidly growing members (such as Cambodia, Lao PDR, Myanmar and Viet Nam) that materialize through numerous channels (reflected in the performance measures such as the Logistics Performance Indicator (World Bank, 2018a); Liner Shipping Connectivity Index (UNCTAD, 2018); and Land and Air Transport Indices).

An important channel which the GTAP model allows us to fully lay out the economy-wide transactions involves the transmission effects through the sectoral and regional (price and quantity) linkages. In so doing, this study allows for a comprehensive assessment of the varying economic effects of improved transport connectivity across sectors. Economy-wide analysis is also useful to investigate wider economic impacts, including the changes in GDP and welfare.

Our assessment of the recent transport connectivity improvements in the ASEAN economies is based on the logistics performance indicators, maritime transport indicators, and land and air transport indicators currently available from published sources and discussed in this paper. We used these indices to calculate a composite index capturing road, air and sea transport connectivity and logistics performance, as discussed earlier. This has provided us with some broad indication of the likely future growth path of transport productivity enhancements in the ASEAN economies.

Based on these broad indications, we analyse three hypothetical productivity improvement scenarios in intermodal transport (land, air and sea transport). They range from 0.25, 0.5 to 1.0 per cent productivity improvement per year in road, sea and air transport activities in ASEAN member economies. We pay particular emphasis on the emerging and rapidly growing members including Cambodia, Lao PDR, Myanmar and Viet Nam. In other words, there is a change in the average productivity of labour and capital that, all else equal, allows the same amount of labour and capital to change real output of the transport services by 0.25, 0.5 and 1.0 per cent in the three hypothetical scenarios analysed here.

The change in productivity impacts on the cost of supplying the intermodal transport services by affecting their requirement for scarce labour and capital resources per unit of output. The productivity change also affects all other industries in the economy both directly through their use of transport services and indirectly through their use of scarce labour and capital. The results of our hypothetical scenario analysis are presented in Table 8.

Table 8. Economy-wide impacts of improvement in multimodal productivity based on GTAP modelling

Country	**Change in multimodal productivity**			**Change in multimodal productivity**		
	0.25%	0.5%	1.0%	0.25%	0.5%	1.0%
	Change in GDP (%)			**Change in Welfare (US$ million)**		
Cambodia	0.06	0.13	0.26	7.3	14.4	28.9
Lao PDR	0.03	0.07	0.15	2.9	5.8	11.7
Viet Nam	0.02	0.04	0.09	42.1	84.3	168.6
Myanmar	0.03	0.06	0.12	18.3	36.7	73.5

As shown in Table 8, for example, all else equal, it is projected that a 1.0 per cent improvement in factor productivity of the transport services will increase real GDP in Cambodia, Lao PDR, Myanmar and Viet Nam by 0.26, 0.15, 0.12 and 0.09 per cent respectively, relative to the baseline case.

Real GDP is a measure of the economic output of each economy. In an economy-wide model such as the GTAP model, an alternative macroeconomic measure is change in consumer welfare (using the equivalent variation measure of welfare change resulting from exogenous shocks).

All else equal, it is projected that a 1.0 per cent improvement in factor productivity of the transport services will raise consumer welfare in Cambodia, Lao PDR, Myanmar and Viet Nam by US$28.9 million, US$11.7 million , US$73.5 million, and US$168.6 million respectively, relative to the baseline case (see Table 8).

The economy-wide impacts discussed above are relatively small as they are related to small changes in multimodal productivity improvements in our hypothetical scenario modelling. It is important to recognise that the results from economic modelling are rarely the only consideration for policy makers. Often the main benefit from economic modelling is that it highlights the broad direction and extent of likely economic impacts of, for example, a potential improvement in productivity. This allows policy makers to understand and consider the economic consequences of their decisions and make more informed decisions (such as invest in freight transport infrastructure and/or enhance the skills/capability of those working in the transport and logistics sectors). In summary, economic modelling contributes to the policy debate by providing a consistent and standard numeraire (monetary values) which can be directly compared.

Barriers to Improving Multimodal Connectivity

It is important to comment here that, from the point of view of the freight transport customers, accessibility and efficiency are major considerations in making decisions to use two or more modes of transport. In this respect, it is the reliability of the service and the transit time which are critical issues, and these could be affected by the level of efficiency of connectivity between the modes.

At a more specific level, it is clear that multimodal transportation, being a continuous flow of goods from one geographical point to another, is sensitive to even a single bottleneck which, impeding the process, can make transit times significantly longer. In this context, a bottleneck could be any impediment that slows or halts the flow of freight traffic. Causes for bottlenecks through a supply chain could be classified as (i) infrastructure bottlenecks, (ii) regulatory bottlenecks and (iii) supply chain dis-functions (see Prentice, 2003).

Infrastructure bottlenecks could be either chronic or temporary in nature. Chronic infrastructure problems may include physical barriers and effects arising from under-investment in infrastructure. Temporary infrastructure problems include weather-related disruptions, spikes in demand for goods and dis-investment (when parts of existing infrastructure are not used or maintained properly) (Prentice, 2003).

The regulatory bottlenecks include direct effects such as unintended consequences of related policy objectives, or indirect effects such as cabotage restrictions. It should be noted that another source of bottlenecks could be when various participants of the supply chain fail to act in their common interest. In such an instance, there may be situations where particular parties benefit from bottlenecks and may not want them removed (Prentice, 2003).

Further, Goh et al. (2008) suggest a classification into regulatory and non-regulatory barriers for the understanding of the integration of multimodal transport networks. Regulatory problems include custom-related barriers and cabotage, whilst non-regulatory problems may include a lack of infrastructure within a participating country or related to a particular mode, as well as a lack of suitable inter-modal connectivity.

In addition to the above comments, there are a number of specific issues and approaches relevant to inter-modal transportation which we see as being important in the current discussion. These include:

- Barriers to inter-modal transportation have been mapped, and the potential for using digital technologies to mitigate some of their impacts have been suggested by Eriksson and Yaruta (2018).
- Transport infrastructure planning should ideally be aligned with trade policy, adopting a supply chain approach. Not practising a strategic approach to infrastructure planning and development could lead to bottlenecks and inefficiencies in the freight transport system.
- Sometimes, critical transport projects may be slow to be implemented, due to the lack of clear understanding and proper mechanism to share risks, costs and benefits among the stakeholders or affected parties.
- Particular regulatory frameworks that govern various transport sectors may become a barrier to achieving multimodal connectivity. A level playing field between modes of transport should be ensured, so that modal choices and utilisation are not distorted.

We assert that improving and maintaining the quality of relevant services throughout the supply chain, is extremely important for multimodal connectivity. This is especially so for economies transitioning from mainly unimodal to multimodal transport contracts. The absence of regulatory frameworks and accreditation systems for multimodal transport operators (MTO) and a shortage of required skills can hinder the transition to multimodal transport connectivity.

Concluding Remarks and Broader Implications

An effective transition from a unimodal to multimodal freight transport arrangement can help improve multimodal connectivity in an economy. This type of transition needs to focus on (i) the implementation of necessary regulatory changes, (ii) the background work of capability building for personnel involved in the relevant supply chains, (iii) ensuring appropriate accreditation and registration of the multimodal transport operators, (iv) improving efficiency of infrastructure across the supply chains, (v) acting to reduce time delays in transporting, trans-loading and ensuring customs clearance, and (vi) improving infrastructure in relation to transport routes and hubs such as airports, sea ports and rail heads.

Direct benefits of multimodal connectivity

As indicated earlier, multimodal connectivity includes individual modes of transport, such as air, sea, road and rail, as well as a range of inter-modal linkages. Examination of the efficiency and effectiveness of the multimodal connectivity in a particular instance is therefore based on a study of a network of nodes (such as sea ports and airports) and of links (such as roadways, railways and air and sea routes).

Improvements in the efficiency and performance of any freight transport mode, either individually or in terms of linkages between modes, would directly benefit the users of these modes of transport. The businesses that use freight transport services would then take advantage of these improvements. This will be done by adjusting their logistics processes and supply chains. Over time, businesses would end up making input substitutions and reconfiguring production processes, thereby improving service and reducing costs.

These economy-wide impacts of transportation system improvements can capture and capitalise on spill-over and other multiplier effects. In this respect, improvements in multimodal connectivity could: (i) lead to an expansion of a transportation network, thereby opening-up both access to previously unreachable areas and by linking key economic centres in a region to central national markets; (ii) expand trade and foreign direct investment due to improvements in cross-border transportation and logistics; (iii) grow export and import volumes as a consequence of reductions in freight costs and time delays; (iv) promote access to interior areas of a country through added transport links which would provide opportunities for local producers to access cheaper land and labour in the country's hinterland; and (vi) interest overseas investors in the opportunities arising from these complementary inland business clusters, prompting direct foreign investment.

Indirect benefits of multimodal connectivity

The introduction of significant levels of infrastructural development and change are characteristically followed by peripheral change and benefit in related areas. It is likely that growth in trade and business investment in the areas previously discussed could also enhance growth in other industrial sectors, such as tourism, manufacturing and retail. In addition, the widening circles of reaction to focussed development in one area of the economy will, in turn, result in substantial changes in service areas, and stimulate increase in employment levels in all positively affected areas of an economy. Further, it is anticipated that improving transportation and logistics within a country would also encourage and support stronger regional integration. Indeed, trade with neighbours can become an important issue due to the increased scale economies in production and transport.

In concert with these wider benefits, it is likely that societal development and poverty reduction across a country would be supported by these improvements in transportation. Increases in connectivity would enable quicker and cheaper movement of basic foodstuffs, agricultural inputs and medicines, which are critically important concerns in social and rural development aims. In addition, environmental benefits, across the whole country, could result from reduced congestion and transportation times. Reduction in air pollution and energy wastage are immediate benefits, but better environmental safety and standards as a result of attention given to upgrading of transportation efficiencies could significantly reduce the risk of environmental hazards and health concerns. It is recognised that, in suitable areas, the improvement in inter-modal connectivity at transport hubs could benefit the growth and the environmental sustainability of tourism in a region.

Policy and industry relevance

The economy-wide modelling undertaken for this study highlights the potential wider economic impacts of productivity improvements in transport services in ASEAN economies with a particular emphasis on emerging and rapidly growing members. The wider economic impacts, which reflect the fact that many of the estimated potential impacts relate to changes in GDP, are discussed in this paper. These changes result from various factors including the change in transport costs underpinned by improvements in transport sector productivity.

As discussed earlier, the improvement in transport sector productivity could potentially lower the cost of supplying transport services by affecting their requirement for labour, capital and other inputs per unit of transport services. For example, a higher level of transport services is supplied at the same unit cost. This has important policy and industry relevance. One area of the policy and industry relevance could be, for example, related to potential reduction in transportation costs. An important measure of transportation costs is the transportation margin. A transport margin is the share of transport cost in the total cost of the product.

The potential impacts of lower transport margins as a result of productivity improvements in road, rail and shipping transport services could be quite substantial. Hummels (2007) points out that studies examining customs data consistently find that transportation costs pose a barrier to trade at least as large as, and frequently larger than, tariffs. According to Gehlhar (2000), a 20 per cent reduction in all transport margins in world trade could potentially have an estimated effect nearly equivalent to complete trade liberalization in world trade. In other words, reducing transport costs could provide potential welfare gains akin to lowering trade barriers. An important lesson for policy makers and industry here is that efforts to improve transport productivity could have considerable potential economic benefits.

Other aspects of policy and industry relevance of the productivity improvements in transport services are centred on logistic improvements, such as reduced trip times and just-in-time delivery, which in turn are expected to reduce warehousing and inventory costs.

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Appendix 1. Brief Description of the GTAP Modelling Approach

The standard Global Trade Analysis Project (GTAP) model used in this study is a multi-region, multi-sector, computable general equilibrium (CGE) model. For a full account of the key assumptions and equations, the reader is directed to Hertel (1997) and Valenzuela et al. (2008).

The model assumes constant returns to scale and perfect competition in all the markets with Walrasian adjustment to ensure a general equilibrium.

As illustrated in Appendix Figure 1 (based on Brockmeier, 2001 and Hertel et al., 2010), each region (e.g. Indonesia) has a representative household that collects all the income in its region and spends it over three expenditure types: private household (consumer), government and savings, in accordance with a Cobb-Douglas utility function.

Each sector is modelled by a representative firm that maximizes profits subject to a nested Constant Elasticity of Substitution (CES) production function. The CES production function combines primary factors and intermediate inputs to produce the sector's final good.

Firms pay wages/rental rates to the regional household in return for the employment of land, labour, capital and natural resources. Firms sell their output to other firms (intermediate inputs), to private households, government and investment. Firms also export tradable commodities and import intermediate inputs from other regions. These goods are assumed to be differentiated by region, following the Armington assumption, and hence the model can track bilateral trade flows.

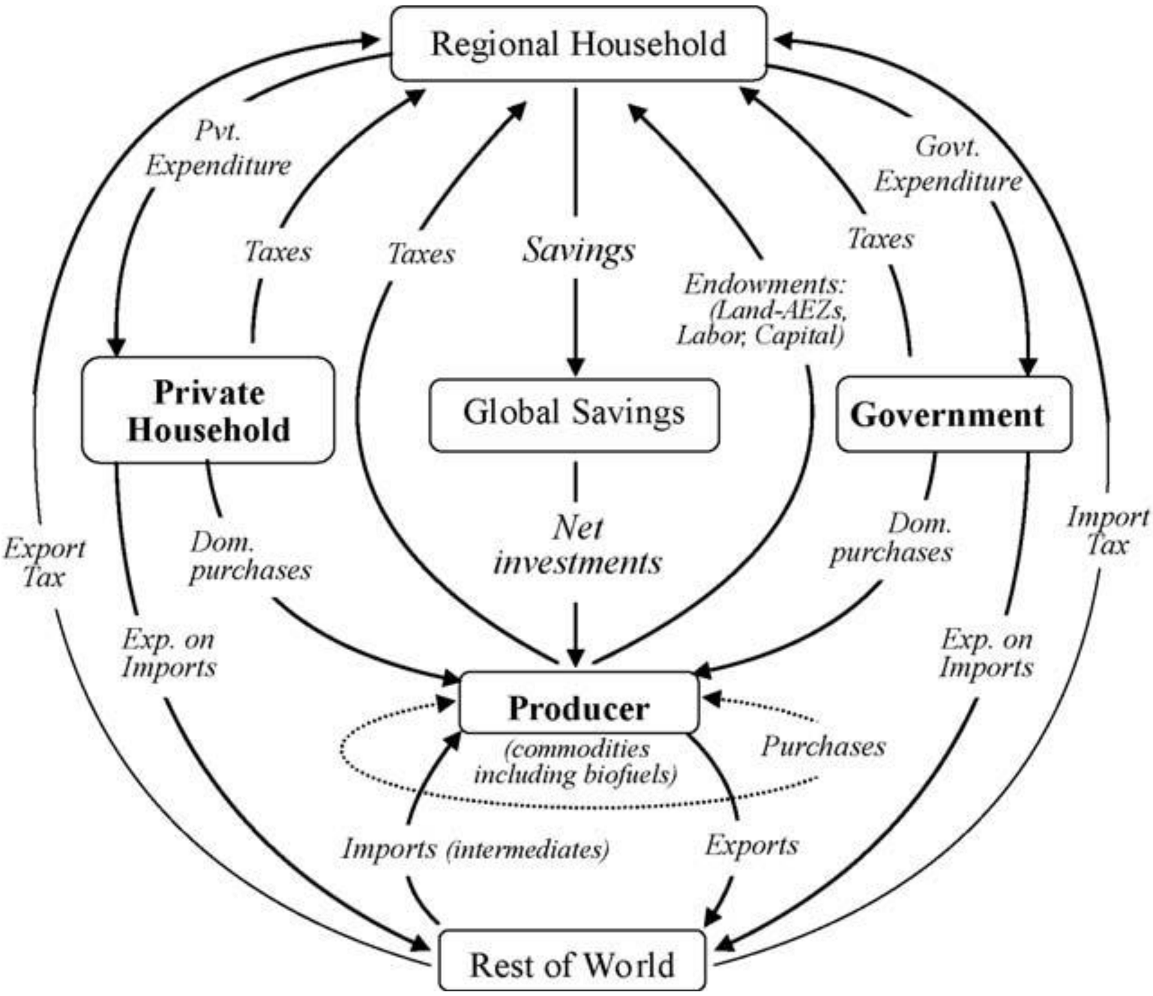
The GTAP database version of the model used in this paper comprises (140 regions aggregated to) 84 regions (with each of the 10 ASEAN countries as separate regions), and 57 sectors of the global trade analysis project database, version 9 (Aguiar et al., 2016). The model was run with the standard comparative static model closure, allowing for the analysis of policy changes relative to what would otherwise be.

In the past, the GTAP model has been used to analyse transport-related policy issues among Asian economies. Examples of such studies relate to international container shipping (see Ma et al., 2005) and international transportation infrastructure development (see Tanabe et al., 2016).

Ma et al. (2005) have developed a method for estimating the international container cargo origin-destination (OD) flows under various hypothetical regional economic integration scenarios and transport technical progress in the East Asian region by using the GTAP model. Since their method provides an approach for estimating the OD flows on a national level, it can be utilized for assessing the policy effects on international trade and transportation. Their research is an important step for forecasting the volume of container handling and trans-shipment on the international container shipping transport networks. Ma et al. (2005) have shown that regional economic integration and transport technical progress in the East Asian economies can have a positive effect on their GDP, trade flow and container OD flows.

Tanabe et al. (2016) have analysed the impacts of improved border-crossing services on international freight transportation in Central Asia (i.e. in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). They have used a coupled modelling framework combining a freight traffic network- assignment model (i.e. Multimodal International Cargo Simulation model for Central Asia (MICS-CA) with a global general equilibrium model (i.e. the GTAP model). Their analysis has shown that improvements in border-crossing service provision significantly decrease international transportation costs and increase trade volumes to and from the Central Asian region in the short run. However, further growth of regional trade could cause traffic congestion, which could lead to an increase in international transportation costs. The analysis thus suggests that further improvement of Central Asian transportation services is a prerequisite for the sustainable growth of regional trade.

Appendix Figure 1. Schematic of the standard GTAP model



Source: Hertel et al. (2010) after Brockmeier (2001)