AMRO
ASEAN +3 MACROECONOMIC RESEARCH OFFICE

Analytical Note

What Does the Real-Time Shipping "Crystal Ball" Tell Us about the Recovery in ASEAN+3 Trade?[1]

October 7, 2020

I. Introduction

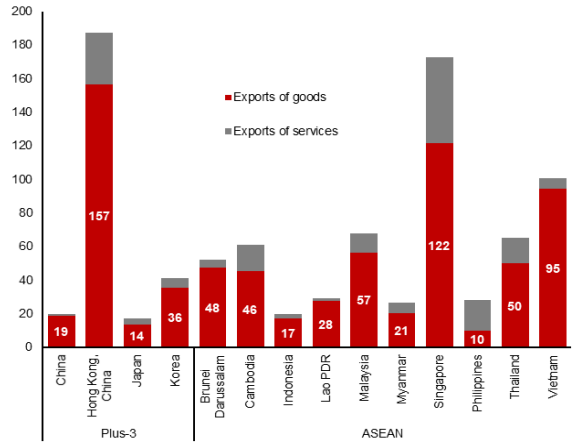
1. **The fast evolving events of the COVID-19 pandemic and their impact on the real economy and markets have highlighted the need for more timely, alternative sources of information.** Compared to traditional—and oftentimes, lagging—economic indicators, alternative data can provide faster, practically real-time information about current economic conditions, and indications about the near-term outlook. Harnessed appropriately, such data can give market participants an edge on the competition (Singh, 2020; and Wong, 2020), strengthen macro-financial surveillance by institutions such as AMRO and the IMF, and inform policymakers in calibrating policy responses well ahead of official data releases.

2. **The pandemic has underscored the importance of ASEAN+3 economies in the global value chain.** The lockdowns severely disrupted international trade, as exporters of final goods (i.e., importers of intermediate goods) and intermediate goods were forced to stop production and delivery, in a rolling wave of shutdowns across the region as the virus spread from country to country. The impact, as evidenced in Q1 and Q2 2020 GDP numbers, was devastating for regional economies, given that merchandise exports range from 10 percent of GDP for the Philippines, to as high as 157 percent in the case of Hong Kong, China (hereafter "Hong Kong") (Figure 1). In this regard, more timely information on trade and the direction of trade could provide a better gauge of the resumption in economic activity in the region or, potentially, any trade diversion that may have occurred as a result of the need to seek more diversified sources of imports and export markets.

3. **In this note, we explore alternative indicators of ASEAN+3 merchandise export activity using near real-time shipping data.** Specifically, we leverage on "big data" from the Automated Identification System (AIS)—a tracking system used by vessel traffic services that utilizes information collected from ship transceivers—to "nowcast" the latest export flows from the ASEAN+3 economies. With at least 70 percent of international merchandise trade by value and volume carried by sea (UNCTAD, 2018), Asia dominates global maritime trade, accounting for 42 percent of the total goods loaded and 61 percent of goods unloaded at ports, in 2017–18 (Figure 2; UNCTAD, 2019).

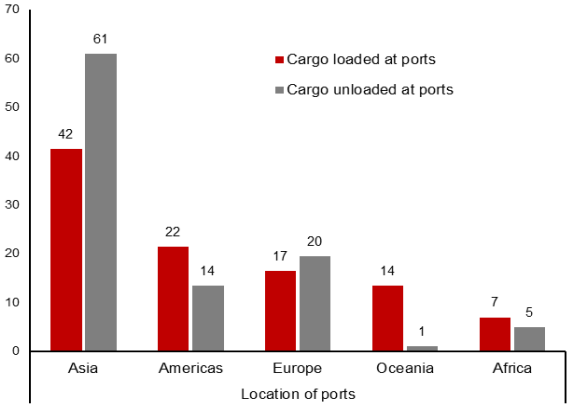
[1] Prepared by Diana del Rosario (Regional Surveillance) and Quach Toan Long (Financial Surveillance); reviewed by Li Lian Ong (Financial and Regional Surveillance); authorized by Hoe Ee Khor (Chief Economist). The authors would like to thank Seung Hyun (Luke) Hong, Xianguo (Jerry) Huang, Ruperto Majuca, Anne Oeking, Chaipat Poonpatpibul, and Wanwisa Vorranikulkij for their useful comments. The views expressed in this note are the authors' and do not necessarily represent those of the AMRO or AMRO management.

Figure 1. ASEAN+3: Goods and Services Exports, 2015–19 Average
(Percent of GDP)



Sources: IMF; national authorities via Haver Analytics; and AMRO staff calculations.
Notes: Figures refer to 2015–18 period for Cambodia. Export contributions to GDP for Lao PDR and Vietnam are estimated from the balance of payments statistics, given that data from the national income account are not available. For Singapore, the breakdown of goods and services is also imputed from the balance of payments.

Figure 2. World: Maritime Trade by Region, 2017-18 Average
(Percent of World Tonnage)



Sources: United Nations Conference on Trade and Development; and AMRO staff calculations.
Note: "Unloaded" refers to the amount of cargo discharged by the vessel at a particular port. Unloading does not necessarily mean that the ship is emptied, given that it may unload at multiple stops. Also, the same vessel could be loading another set of cargo at the same time.

II. Alternative Data: Shipping

4. **Official export data are often released with a lag, leaving room for alternative indicators to fill information gaps.** In the ASEAN+3 region, they are often published between 1–6 weeks following the end of the reporting month (Table 1). Hence, near real-time, alternative indicators derived from the AIS-sourced shipping data could potentially be used to deduce trade activity—and consequently, forecast GDP growth—ahead of official data releases. Ships carry the AIS device as a means of increasing navigational safety in international waters. The device allows vessels to broadcast a plethora of key shipping information—name, speed, destination, estimated time of arrival, and draught, among others—to other vessels, as well as to terrestrial and satellite receivers every few seconds or minutes, depending on the type of signals being transmitted.

5. **The vast amount of high-frequency AIS data serves various purposes.** Their uses include the monitoring of global fleet emissions and the generation of seaborne trade patterns (Figure 3). Since 2004, commercial ships of at least 300 gross tonnage have been required by the International Maritime Organization to be fitted with the AIS device, which has made possible the estimation of trade flows on a more timely and granular basis (Jia, Prakash, and Smith, 2019). The data are available from commercial vendors such as MarineTraffic.

6. **We narrow down the large and complex AIS data feed to focus on vessel activity at ASEAN+3 ports to derive relevant export indicators.** Although AIS information is available in real time, our particular dataset is updated daily and subsequently aggregated on a monthly basis for comparison against official export statistics. For analytical purposes, we apply a three-step **filtering process,** incorporating **machine-learning techniques,** on the port call dataset to gauge export activity (Appendix I). Two key indicators of outbound vessel traffic and volume are derived from the filtered port call data, namely:

- *Ship count*, which refers to the total number of overseas-bound ships in a country or economy in a single day—this indicator is a rough proxy of export flows, in terms of its ability to gauge traffic at the ports;

- *Cargo tonnage*, a measure of export volume, which is imputed from the ships' draught (the vertical distance between the ship's waterline and the bottom of the hull) and deadweight tonnage (the ship's maximum carrying capacity, expressed in tons, which includes the ship's cargo, fuel, crew, and other loads) (Appendix II). The heavier the ship's cargo, the greater its draught.

Table 1. ASEAN+3: Frequency and Timeliness of Official Export Statistics

Economy	Frequency	Latest data (as of Oct 5)	Timing of data release (weeks after end of reporting month)	Schedule of next data release
Plus-3				
China	Monthly	Aug 2020	1	Oct 13 for Sep
Hong Kong, China	Monthly	Aug 2020	4	Oct 27 for Sep
Japan*	Monthly	Aug 2020	3	Oct 19 for Sep
Korea*	Monthly	Sep 2020	1	Nov 1 for Oct
ASEAN-5				
Indonesia	Monthly	Aug 2020	2	Oct 15 for Sep
Malaysia	Monthly	Aug 2020	4	Oct 28 for Sep
Philippines	Monthly	July 2020	6	Oct 9 for Aug
Singapore	Monthly	Aug 2020	3	Oct 16 for Sep
Thailand	Monthly	Aug 2020	4	Oct 30 for Aug
BCLMV				
Brunei	Monthly	Jun 2020	> 6	NA
Cambodia	Monthly	Jun 2020	> 6	NA
Lao PDR	Quarterly	Jun 2020	> 6	NA
Myanmar	Monthly	Jul 2020	> 6	NA
Vietnam	Monthly	Sep 2020	0	Oct 27--31 for Oct

Sources: National authorities; and AMRO staff estimates.
Note: * Both Japan and Korea additionally report exports for the first 10 and 20 days of the month, released about two weeks after the last day of coverage for Japan and one day after for Korea.

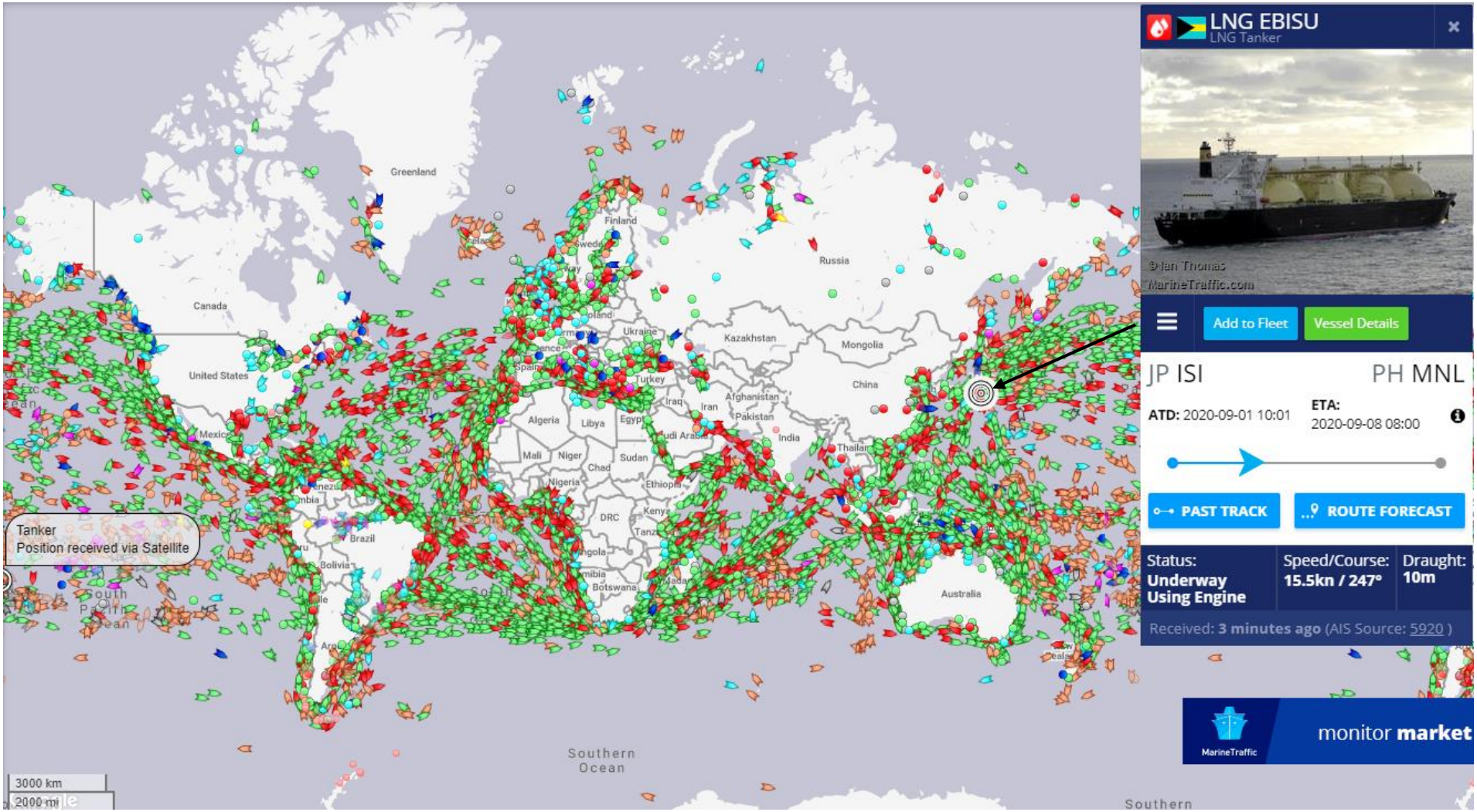
III. Alternative Data: Backtesting

7. **The shipping indicators are backtested to determine their accuracy vis-a-vis official export statistics for the ASEAN+3 economies, and the results are affirmative.**[2] Both the *ship count* and *cargo tonnage* indicators are highly correlated with monthly export values for China; Hong Kong, China (hereafter "Hong Kong"); Japan; and Singapore, at more than 75 percent (Table 2; Appendix Figures 5 and 6).[3] The indicators also show a decent fit for Indonesia, Korea, Malaysia, and the Philippines, with correlations ranging from 47–75 percent. The results are encouraging given that: (1) the lack of a price component in the shipping indicators means that they are unable to fully capture export values; and (2) not all exports that are reflected in the official statistics are transported by sea (Figure 4). For example, maritime transport accounts for less than 15 percent of Hong Kong's exports, while almost 40 percent are sent by air and another 44 percent by land, likely to China.

[2] Lao PDR is excluded from the exercise given that it is a landlocked country; the Savannakhet dry port does not host vessels and hence, does not contribute to the AIS.

[3] We only refer to correlations for the 2019–20 period, given that MarineTraffic has reported issues with several of their data feeds for 2017–18, reducing the reliability of data quality and quantity.

Figure 3. Global Marine Traffic via the Automated Identification System (AIS)



Source: MarineTraffic (https://www.marinetraffic.com/en/ais/home/centerx:101.3/centery:31.4/zoom:2).
Note: Colors represent particular vessel types. Green refers to cargo vessels (bulk carriers, containers, general cargo), red for tankers (gas, oil, other), blue for passenger vessels.

8. **For some economies, the shipping indicators are able to track official exports better following adjustments in two areas.** Specifically, calibrations for timing and concentration of exports help improve correlations with official export statistics:

- Correlations rise when *ship count* and *cargo tonnage* indicators are lagged.[4] They strengthen significantly for Brunei Darussalam (hereafter "Brunei") when the indicators are shifted back by a month against exports (Appendix III). One-to-three-month lags also improve the fit for Cambodia, Myanmar, and Thailand, although overall correlations are relatively weaker. Despite the timing adjustments, the indicators are still able to provide information beyond the period covered by official statistics. In contrast, Vietnam's data show potential as a two-month leading indicator of official export statistics.

- Alignment with official export statistics also improve once the shipping indicators are refined to reflect the country's dominant exports. In Brunei's case, the fit is materially enhanced when only tankers, which represent oil and gas shipments that account for over 80 percent of the country's total exports, are included. Likewise, Vietnam's indicators perform better when confined to the more dominant container ships among vessel types (Appendix I).

9. **Tests on the *cargo tonnage* indicator against official export volume statistics reveal a good fit for several economies.** Official export volume data are not readily available for all ASEAN+3 economies. But, for economies where the data are available, such as Hong Kong, Indonesia, Japan, and Malaysia, the *cargo tonnage* indicator has a correlation of at least 53 percent over the 2015–20 period; the indicator shows relatively weaker correlations with the respective export volume statistics for China, Korea, the Philippines and Thailand (Table 3; Appendix Figure 7). Narrowing the sample period to 2019–20 considerably strengthens the correlations for China, Japan, and Korea—and to a certain extent, the Philippines, and Thailand—but not necessarily for Malaysia.

10. **Apart from correlations in levels, a fair degree of correlation can also be observed in year-over-year terms.** The indicators can then provide information about relative export performance in the present month, day or week in most cases, beating official statistics (Appendix Figure 8). To enhance the fit, Brunei, Hong Kong, the Philippines, and Thailand would have to lose a month's information; however, the indicators would still be able to forecast export performance before the official data for that month are released. Similarly, applying lags of 1–2 months for Cambodia and Myanmar also improves the correlation between the shipping indicators and the official export statistics in the year to date, although the results should be interpreted with caution given the weak historical correlations. Vietnam appears to be a special case, with the indicators seemingly able to track export flows one month ahead.

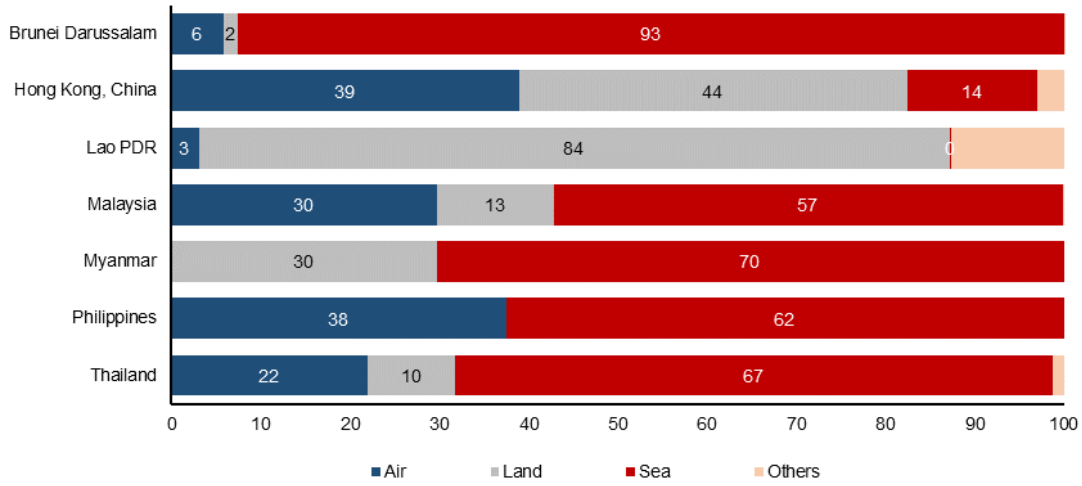
[4] Timing issues between the AIS- and customs-based trade data may arise for several reasons: (1) the recording of physical ship departures and when cargo is invoiced or considered exported; (2) delays in customs processing; and (3) the use of trans-shipment storage facilities in free trade zones (Adland, Jia, and Strandener, 2017).

Table 2. ASEAN+3: Historical Correlations between Official Export Values and Shipping Indicators, 2019–20
(Percent)

	Exports USD vs.	
	Ship Count	**Cargo Tonnage**
Plus-3		
China	91***	92***
Hong Kong, China	84***	87***
Japan	86***	82***
Korea	69***	63***
ASEAN-5		
Indonesia	47**	75***
Malaysia	71**	70***
Philippines	75***	65**
Singapore	91***	79***
Thailand[a]	24	54*
BCLMV		
Brunei[b]	67***	68***
Cambodia[c]	47*	30
Myanmar[d]	38	62**
Vietnam[e]	58**	54**

Sources: MarineTraffic; and AMRO staff calculations.
Notes:
a: T+1 (months) for ship count, cargo tonnage;
b: T+1 for ship count, cargo tonnage; and for tankers only;
c: T+3 for ship count, cargo tonnage; exports to countries (Lao PDR, Thailand, and Vietnam) that share a land border with Cambodia are excluded from official exports;
d: T+2 for ship count, cargo tonnage; exports to countries (China, Bangladesh, India, and Thailand) that share a land border with Myanmar are excluded from official exports;
e: T-2 for ship count, cargo tonnage; for containerships only.
***, **, * represent 1, 5, and 10 percent levels of significance, respectively. The period covered refers to daily data from January 2019 to July 2020. We exclude correlations covering earlier periods as MarineTraffic reported issues with several of their data feeds in 2017–18, leading to wider fluctuations in data quality and quantity. Appendix Figures 5 and 6 present the correlation charts for each ASEAN+3 economy pair.

Figure 4. Select ASEAN+3: Exports by Modes of Transport, 2019
(Percent of total value)



Sources: National authorities (for Hong Kong, China data) via Haver Analytics; UN Comtrade; and IMF staff calculations.
Notes: Only ASEAN+3 economies with available data are reported. The bulk of "Others" refers to rivers for Hong Kong, and pipelines and cables for Lao PDR.

Table 3. ASEAN+3: Historical Correlations between Official Export Volumes and Cargo Tonnage, 2019–20
(Percent)

Economy	Official Statistics Item	Exports Volume vs. Cargo Tonnage	
		2015–20	2019–20
Plus-3			
China	Freight carried at coastal ports (million tons)	48**	86***
Hong Kong	Quantity index (2018=100)	74***	78***
Japan	Real exports (2015=100)	53***	73***
Korea	Cargo loaded (thou tons)	44***	75***
ASEAN-4			
Indonesia	Merchandise exports (thousand tons)	77***	76***
Malaysia	Exports volume index (2010=100)	57***	50**
Philippines	Merchandise exports (thousand kilograms)	25**	40
Thailand	Exports volume index (2012=100)	37***	41*

Sources: MarineTraffic; and AMRO staff calculations.
Notes: For series with reference years, both the official series and the shipping indicator are rebased to 2019 for consistency.
***, **, * represent 1, 5, and 10 percent levels of significance, respectively.

IV. "Nowcasting" Exports

11. **The AIS-derived indicators point to continuing, albeit fragile, recovery in ASEAN+3 exports post-lockdowns.** The shipping information, which exhibits largely significant correlations with official export data, may be used to "nowcast" the growth in export values (Figure 5). For example, both the *ship count* and *cargo tonnage* indicators suggest that exports from China and Japan continued to improve in September from the same period a year ago, and further strengthened in the first 4 days of October (Figure 6). For the rest of the ASEAN+3 economies, exports may have increased in September for Brunei, Malaysia, Singapore, and Thailand, but contracted for Hong Kong, Indonesia, and the Philippines; information from the first four days of October indicates that exports fell for Indonesia, Korea, Singapore, and Vietnam (Appendix Figure 8).

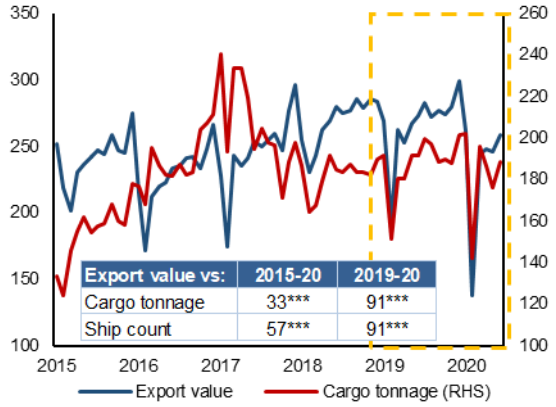
12. **A caveat in using the indicators is that they tend to perform better at predicting turning points than actual export growth outturns.** The predictive power of both the *ship count* and *cargo tonnage* indicators weakens when exports are dominated by price effects or changes in modes of transportation. For instance, the indicators may overestimate actual outcomes when unit prices—which are not captured—are a drag on export growth, as was the case for Malaysia from March to May and July to August (Appendix Figure 8). In addition, large swings in the other modes of shipment—such as via land in the case of Hong Kong since end-2019, and both air and land for Malaysia, especially from June through August (Figure 7)—could also distort the predictive ability of those indicators.[5]

13. **Notwithstanding buoyant land-based and airborne trade for some economies, overall trade trends in the region are mixed.** With maritime transport accounting for the bulk of international trade, especially for the ASEAN+3 region, the renewed downturn in

[5] The pick-up in Hong Kong's land-based shipments—primarily re-exports likely bound for China—could be in line with the stronger demand for goods from emerging Asia amid the re-onshoring of production facilities from the mainland to the latter (Rasid and Gao, 2020).

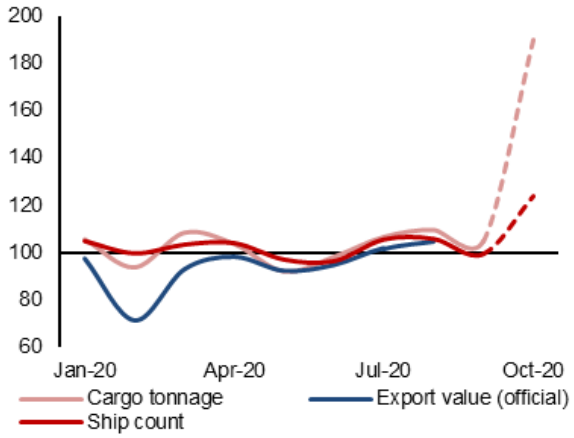
shipping activity for some economies (notably, Indonesia and Korea in October; and Vietnam in October and November) suggests that the external environment remains fragile, and the massive disruptions wreaked by the pandemic have yet to be fully unwound. The robust land and air shipment data may have been temporarily boosted by the urgent delivery of certain goods, such as medical supplies and work-from-home equipment, or to catch up with production after months of limited operations, rather than an organic build-up in demand.[6]

Figure 5. China and Japan: Correlations between Official Export Statistics and Ship Cargo Tonnage
(Billions of US dollars; thousands of tons)



Sources: MarineTraffic; and AMRO staff estimates.
Notes: The data end in June 2020. The inset table reports correlation coefficients for the specified series. *** refers to statistical significance at the 1 percent level.

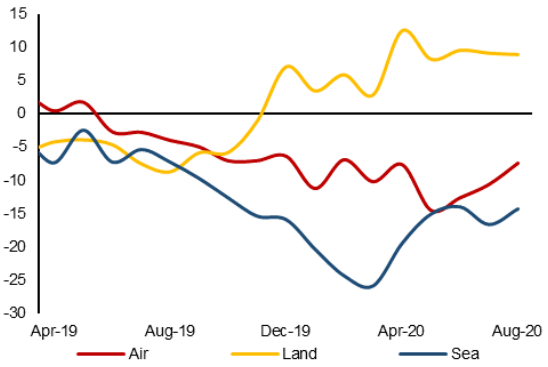
Figure 6. China and Japan: Predictive Power of the AIS-Derived Indicators
(Corresponding month in 2019 = 100)



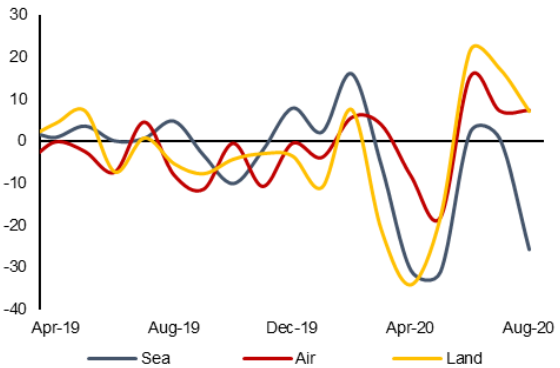
Sources: MarineTraffic; and AMRO staff estimates.
Notes: October 2020 data for the AIS-derived indicators refer to the first 4 days of the month. Official export statistics for China and Japan are until August 2020.

Figure 7. Selected ASEAN+3 Economies: Official Export Growth by Modes of Transport
(Percent year-over-year)

Hong Kong, China
(3-month moving average)



Malaysia



Sources: National authorities via Haver Analytics; and AMRO staff estimates.

[6] For example, China's railway cargo to Europe recorded a 73 percent year-over-year increase in July, and 41 percent for the first seven months of 2020 (South China Morning Post, 2020).

V. Conclusion

14. **Near real-time shipping indicators appear to track the official export statistics of most ASEAN+3 economies reasonably well, and could be useful policy tools.** Given the importance of trade for this region's economies and the lag in official data releases, these alternative indicators could provide timely insights that can enhance surveillance and policymaking in the current fast-evolving environment of heightened uncertainty. With the indicators pointing to a still-fragile external environment, mainly because COVID-19 infection rates remain high in several parts of the world, authorities may need to stand ready to calibrate fiscal and monetary policies to counter any concerted signs of weakness among the regional economies.

Appendix I. Extracting Signals from Noise

Port call data from the Automated Identification System (AIS) contain voluminous information on incoming and outgoing vessels detected at ports in ASEAN+3 economies that can be used to gauge trade activity well ahead of official releases. A port call is recorded when a vessel enters the port's boundary—defined as a bounding box by the vendor, MarineTraffic—at virtually zero speed.[7] Our sample period covers activity from January 1, 2015 to the present. To estimate international export activity, a three-step filtering process is applied to the port call dataset; the approach used follows Arslanalp, Marini, and Tumbarello (2019), albeit with some modifications. The following characteristics are eliminated at each step of the filtering process:

- ***Step 1: Vessels that do not generate goods trade activity.*** This step filters out bunkering tankers or vessels involved in the provision of fuel to other ships at seaports; passenger ships; sailboats; and leisure craft. Port calls at anchorage are also excluded, given that they are likely to comprise vessels that require repairs or those waiting for berth facilities. At this point, the filtered port call data would be left with the following vessel types: containerships, general cargo, bulk carriers, and oil, gas and other tankers.

- ***Step 2: Vessels that stay briefly at the port.*** The rationale is that ships require a reasonable amount of time to unload and load cargo before departure. We follow Arslanalp, Marini, and Tumbarello (2019) in excluding port calls where ships remain at port for fewer than 5 hours, which account for 15 percent of the total number of remaining port calls from *Step 1*.[8] However, we include port calls of ships that the authors deem to have stayed "too long," i.e., over 60 hours, at port (perhaps for repairs and maintenance), as long as they eventually depart the port for another country (see *Step 3*). The median stay of the vessels at port varies across vessel types, ranging from 14 hours for container ships to 2.5 days for bulk carriers (Appendix Figure 1).

- ***Step 3: Domestic voyages.*** We also eliminate domestic ship movements from the port call dataset by using information on a ship's next destination. Where vessels make multiple stops at various ports within a country before heading overseas, the domestic trips are filtered out and the international leg is retained. Intuitively, archipelagic countries or those with long coastlines—such as China, Indonesia, Japan, the Philippines, and Thailand— tend to record a substantial proportion of domestic voyages (Appendix Figure 2). The distribution of outbound vessel types for each of the 13 ASEAN+3 economies is a broad reflection of the goods exported by a particular economy (Appendix Figure 3).[9]

---

[7] As an alternative to proprietary port call data, Cerdeiro and others (2020) build the data from scratch using historical AIS messages and a spatial clustering algorithm.

[8] Although the percentage appears quite high, about 95 percent of these ships—typically, general cargo and oil tankers—traverse within the same country, and would be excluded anyhow in *Step 3*.

[9] In some instances, the type of cargo carried by a vessel may be narrowed down according to the vessel type. Bulk carriers are designed to transport unpackaged dry bulk cargo, such as grain, coal, ore, steel coils, and cement. Tankers can be sub-classified according to the type of liquid cargo they carry, such as oil, gas, and chemical tankers. However, general cargo and container vessels carry different types of packaged items, which cannot be identified using AIS data alone.

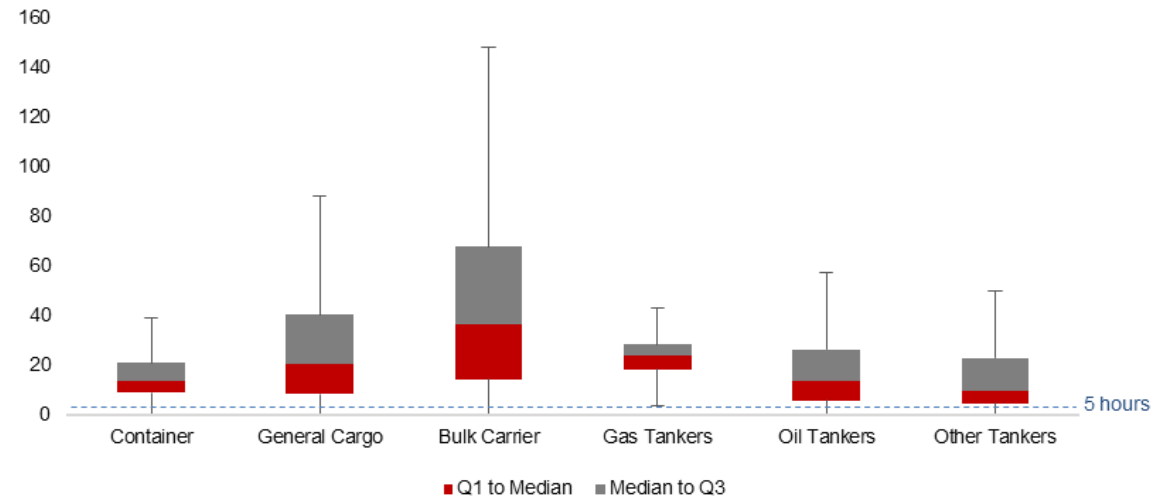
The information on a vessel's next destination in *Step 3* is limited by our port call dataset and the sample period. Given that our dataset only covers the ASEAN+3 region, outbound ships that travel beyond the ASEAN+3 region will be recorded as going to an unknown destination. Moreover, as a vessel's destination is determined by its subsequent port call, there will naturally be a build-up of vessels with unknown destinations toward the end of the sample period. To address this issue, we extract the outbound vessels with unknown destinations from the group of both inbound and outbound vessels with unknown destinations, and apply the following steps:

- ***Step 3.1:*** A vessel (that can be inbound or outbound) with an unknown destination and with a sailing period to the next port that is greater than the travel time of an inbound vessel is considered to be outbound. For each vessel type, the travel time of an inbound vessel is determined by the 95th percentile of the distribution of all its historical travel times. We find that inbound ships have a median travel time of about one day before reaching the next local port.

- ***Step 3.2:*** Remaining vessels with unknown destinations from *Step 3.1* are then subjected to a machine-learning algorithm called *random forest* to determine the ship's next destination. This step is particularly applicable to ships that have left port **prior** to the sample cut-off date but have not yet arrived at its next port of call by the sample cut-off date.

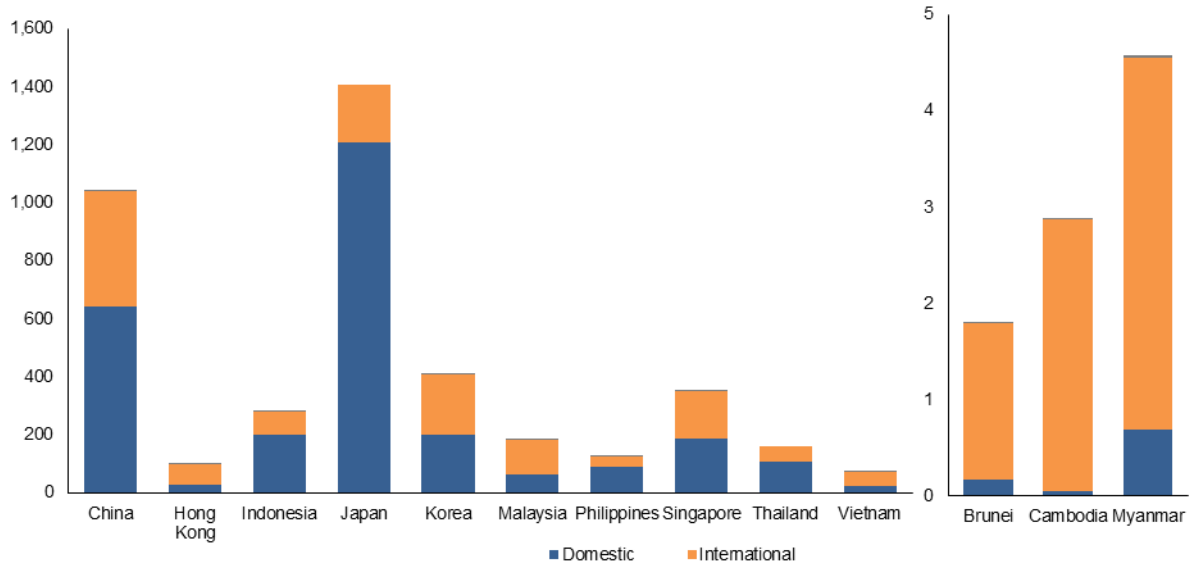
Overall, the three-step filtering process retains 1.4 million trips from the 8.0 million total ASEAN+3 port calls from 2015–20, with *Steps 1* and *3* eliminating larger proportions of the port call data (Appendix Figure 4). The final dataset is equivalent to an average of over 20,000 ships departing from all ports throughout the region in a given month to any other country in the world (including those in the region).

Appendix Figure 1. ASEAN+3: Length of Stay at Port, by Vessel Type
(Number of hours)



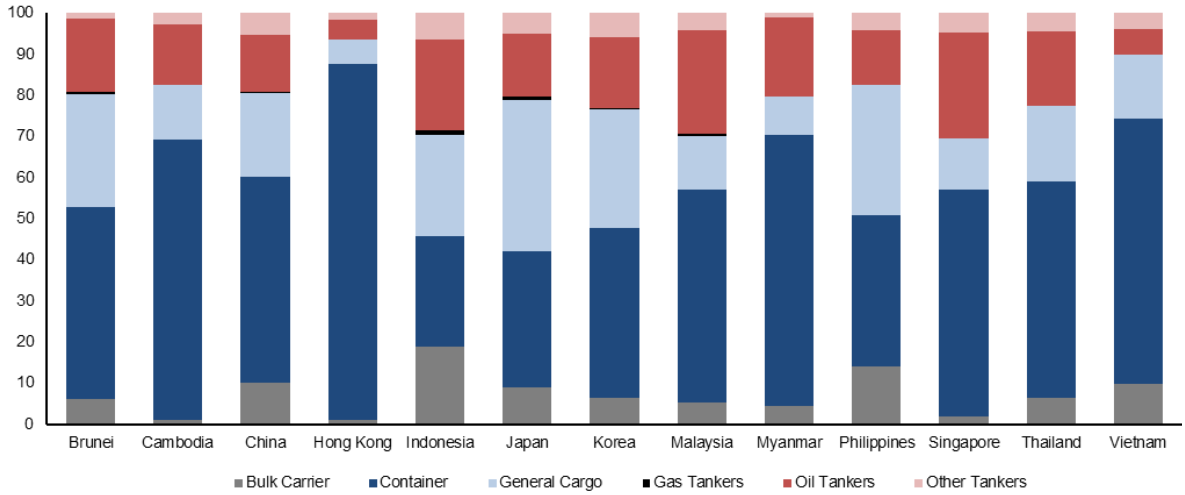
Sources: MarineTraffic; and AMRO staff estimates.
Note: The top to bottom ends of the line represent 99.7 percent of the total number of ships by vessel type. The above chart has been derived from a dataset of daily frequency covering the period January 2015–August 2020 for all ports in the ASEAN+3 region, after applying Step 1 of the filtering process.

Appendix Figure 2. Number of Domestic and International Voyages, by Economy
(Thousands of ships)



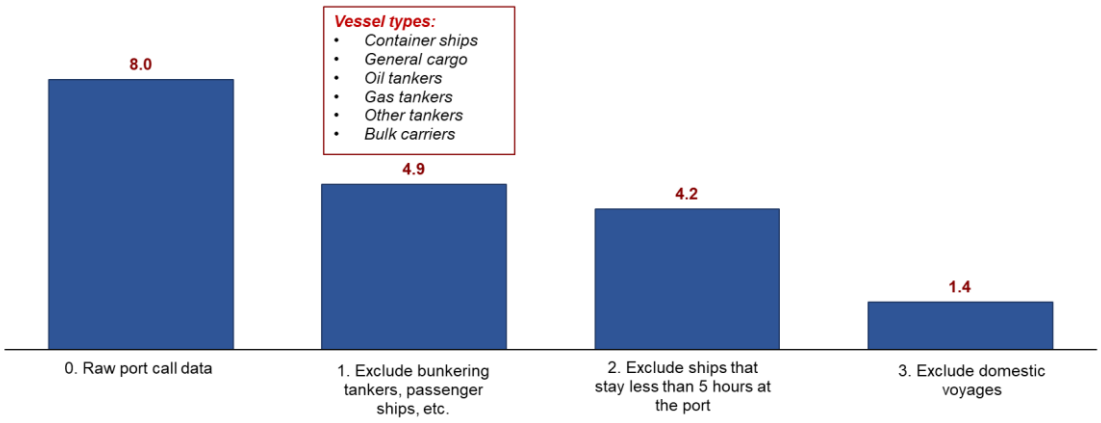
Sources: MarineTraffic; and AMRO staff estimates.
Note: The above chart has been derived from a daily data covering the period January 2015–August 2020 for all ports in the ASEAN+3 region, after applying Steps 1 and 2 of the filtering process. Domestic and "Unknown" voyages are excluded in Step 3. For an island state like Singapore, checks against other sources suggest that the large number of domestic voyages may be erroneous, and refers instead to international voyages, such as those to nearby islands of Indonesia and Malaysia. The errors may arise because of the lack of, or poor, reception at AIS stations in the other country, leaving gaps in data points and consequently, errors in voyage matching. For example, we have observed that successive domestic voyages for the same vessel spanning a few weeks or months record changes in draught, suggesting that the ships could have stopped elsewhere before returning to Singapore.

Appendix Figure 3. Distribution of Vessel Types, by Economy
(Percent of total)



Sources: MarineTraffic; and AMRO staff calculations.
Note: The above chart has been derived from a dataset of daily frequency covering the period January 2015–August 2020 for all ports in the ASEAN+3 region,, after applying all three steps in the filtering process.

Appendix Figure 4. ASEAN+3: Valid Port Calls per Filter Rule
(Millions of ships)



Sources: MarineTraffic; and AMRO staff calculations.
Note: The above chart has been derived from a dataset of daily frequency covering the period January 2015–August 2020 for all ports in the ASEAN+3 region,.

Appendix II. Calculating Cargo Tonnage

An outgoing vessel's cargo weight can be estimated from its draught and deadweight tonnage information. If we define CT_{it} as the cargo tonnage of overseas-bound vessel i at time t, then following Cerdeiro and others (2020), the indicator may be calculated using the following formula:

$$\boldsymbol{CT_{it} = dwt_i \times \frac{d_{it} - d_{i,ballast}}{d_{i,max} - d_{i,ballast}}},$$

where:

d_i and dwt_i denote the draught and deadweight tonnage of vessel i, respectively;
$d_{i,max}$ is the vessel's design draught, proxied by the maximum draught within the sample period from January 1, 2015 to the present; and
$d_{i,ballast}$ is the ballast draught or the draught when no cargo is being transported by vessel i.

A vessel's cargo tonnage is thus expressed as a fraction of its maximum capacity, after estimating its capacity utilization rate from the draught information.

Data on *deadweight tonnage* and *maximum draught* are available in the port call dataset, but ballast draught is not. Consequently, the ballast draught may be derived from available information in the port call dataset as follows:

- First, calculate the ratio of the minimum draught to the maximum draught for each vessel i, although the minimum draught may not necessarily be the actual ballast draught, given that the vessel may never have been empty within the sample period.

- Second, take the median of the ratios in Step 1 within a vessel size grouping for each vessel type (that is, container, general cargo, bulk carrier, and tanker) in order to obtain a fair proxy of the ballast draught for vessel i. If we let mr_{rs} denote the median ratio corresponding to vessel type r and size group s, then the ballast draught can be derived according to the following formula:

$$\boldsymbol{d_{i(r,s),ballast} = mr_{rs} \times d_{i,max}}.$$

The grouping is further calibrated to account for the fact that ship sizes can vary greatly within vessel types. We deviate slightly from the methodology applied by Cerdeiro and others (2020), which uses deadweight tonnage tertile, by grouping vessels according to their commercial sizes for every vessel type.[10] Our results are consistent with those from the original methodology.

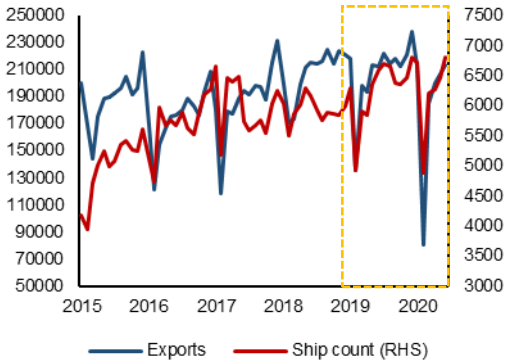
[10] For example, a bulk carrier can be classified according to the following commercial sizes: small feeder, Handysize, Handymax MR, Handymax, Panamax, Capesize, Post Panamax, and Ultra Large Bulk Carrier, in order of increasing median deadweight tonnage.

Appendix III. Comparing Official Export Value Statistics with the Shipping Indicators

Appendix Figure 5. ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Ship Count

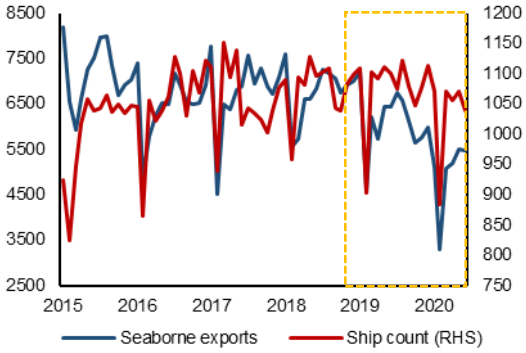
(Millions of US dollars; number of ships)

Plus-3: China



Period	Correlation coefficient
2015-2020	57% ***
2019-2020	91% ***

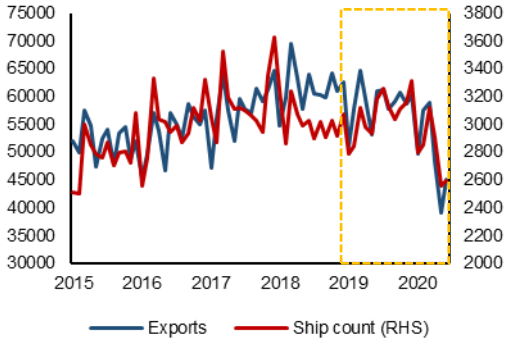
Plus-3: Hong Kong, China



Period	Correlation coefficient
2016-2020	36%
2019-2020	84% ***

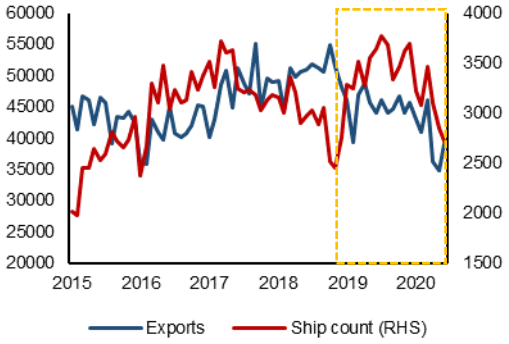
Note: Only seaborne exports are included.

Plus-3: Japan



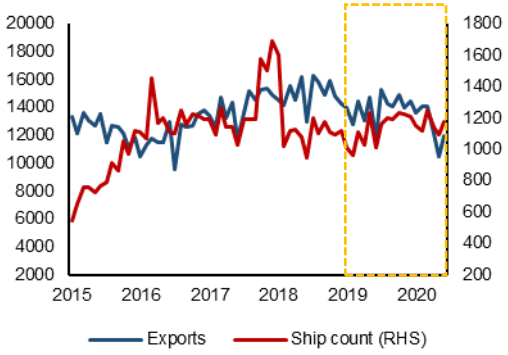
Period	Correlation coefficient
2015-2020	66% ***
2019-2020	86% ***

Plus-3: Korea



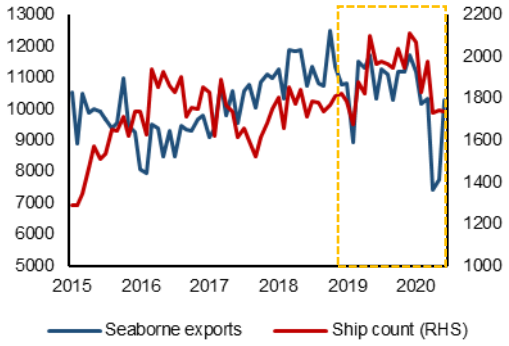
Period	Correlation coefficient
2015-2020	10%
2019-2020	69% ***

ASEAN-5: Indonesia



Period	Correlation coefficient
2015-2020	32% **
2019-2020	47% **

ASEAN-5: Malaysia



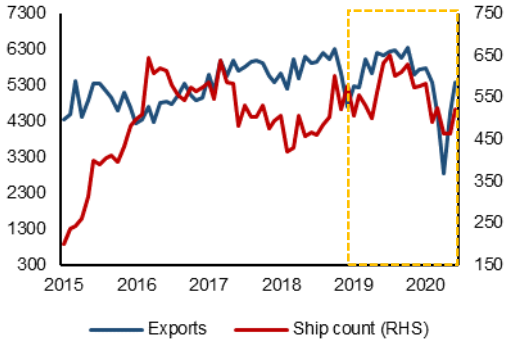
Period	Correlation coefficient
2015-2020	30% **
2019-2020	71% **

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix Figure 5 (Cont'd). ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Ship Count

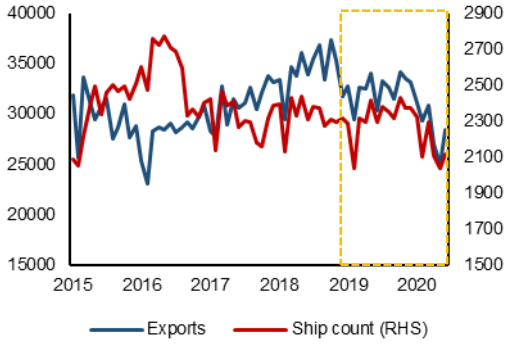
(Millions of US dollars; number of ships)

ASEAN-5: Philippines



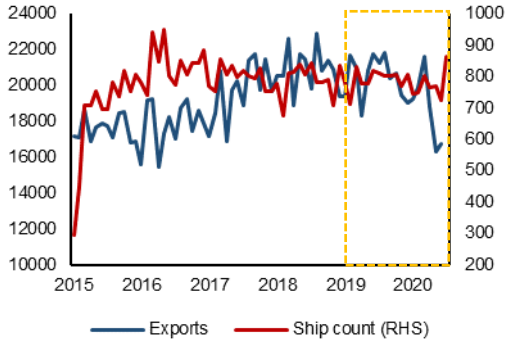
Period	Correlation coefficient
2015-2020	33% ***
2019-2020	75% ***

ASEAN-5: Singapore



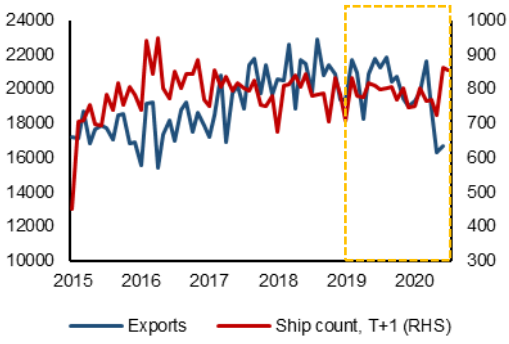
Period	Correlation coefficient
2015-2020	-8%
2019-2020	91% ***

ASEAN-5: Thailand



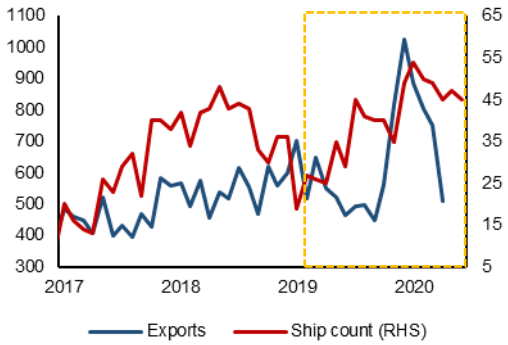
Period	Correlation coefficient
2015-2020	18%
2019-2020	42% *

ASEAN-5: Thailand *(adjusted)*



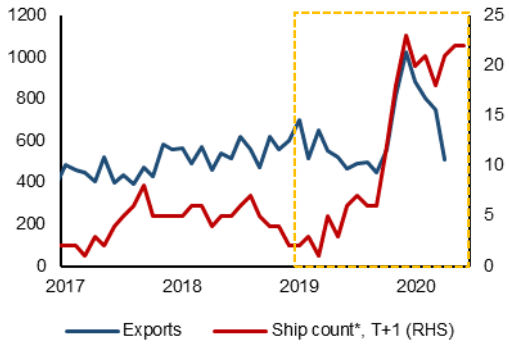
Period	Correlation coefficient
2015-2020	10%
2019-2020	24%

BCMV: Brunei Darussalam



Period	Correlation coefficient
2015-2020	59% ***
2019-2020	40%

BCMV: Brunei Darussalam *(adjusted)*



Period	Correlation coefficient
2015-2020	72% ***
2019-2020	67% ***

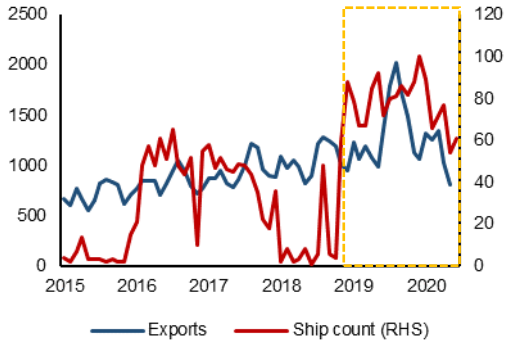
Note: Includes tankers vessel type only.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix Figure 5 (Cont'd). ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Ship Count

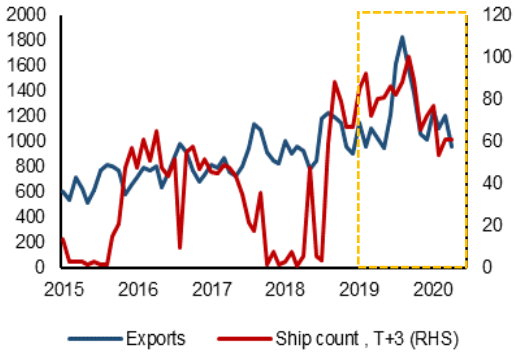
(Millions of US dollars; number of ships)

BCMV: Cambodia



Period	Correlation coefficient
2015-2020	52% ***
2019-2020	18%

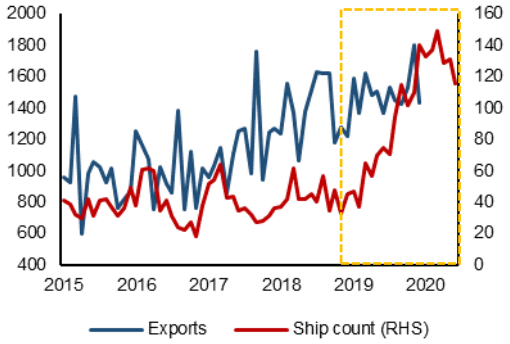
BCMV: Cambodia *(adjusted)*



Period	Correlation coefficient
2015-2020	54% ***
2019-2020	47% *

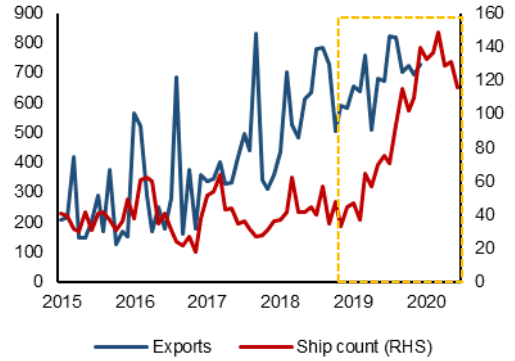
Note: Countries that share a land border with Cambodia (Lao PDR, Thailand, and Vietnam) are excluded from official exports.

BCMV: Myanmar



Period	Correlation coefficient
2015-2020	43% ***
2019-2020	8%

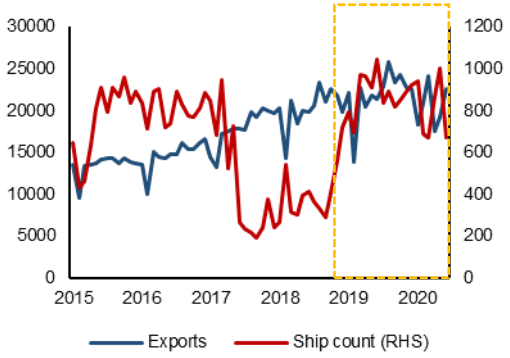
BCMV: Myanmar *(adjusted)*



Period	Correlation coefficient
2015-2020	48% ***
2019-2020	38%

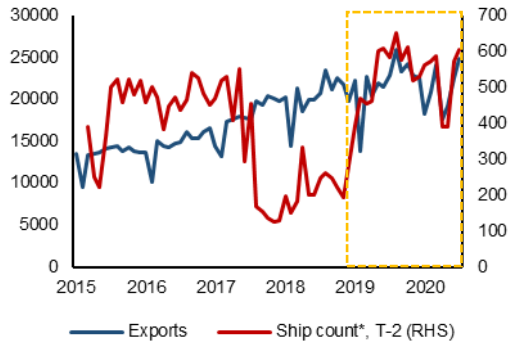
Note: Countries that share a land border with Myanmar (China, Bangladesh, India, and Thailand) are excluded from official exports.

BCMV: Vietnam



Period	Correlation coefficient
2015-2020	-15%
2019-2020	2%

BCMV: Vietnam *(adjusted)*



Period	Correlation coefficient
2015-2020	-3%
2019-2020	58% **

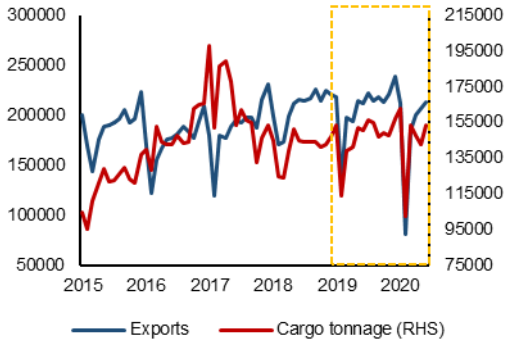
Note: Includes containerships only.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix Figure 6. ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Cargo Tonnage

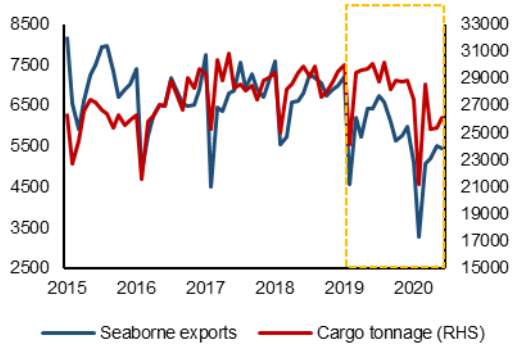
(Millions of US dollars; thousands of tons)

Plus-3: China



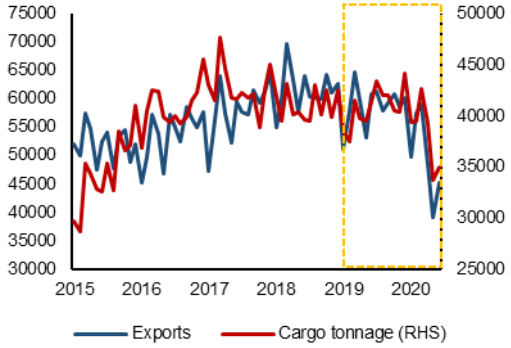
Period	Correlation coefficient
2015-2020	32% ***
2019-2020	92% ***

Plus-3: Hong Kong, China



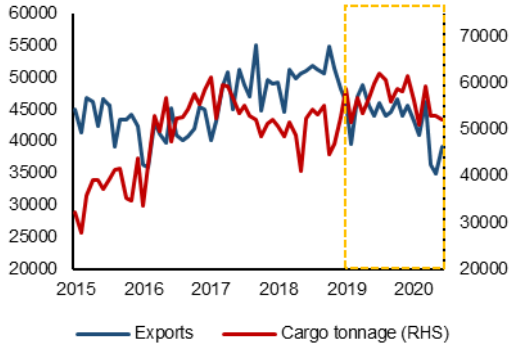
Period	Correlation coefficient
2016-2020	45% ***
2019-2020	87% ***

Plus-3: Japan



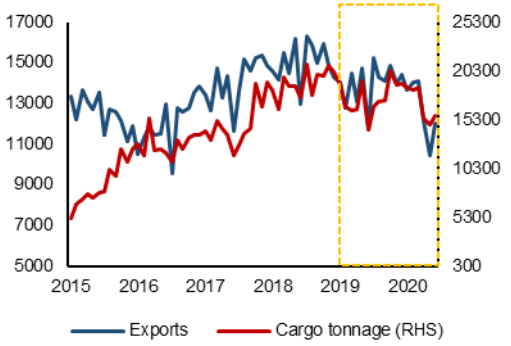
Period	Correlation coefficient
2015-2020	57% ***
2019-2020	82% ***

Plus-3: Korea



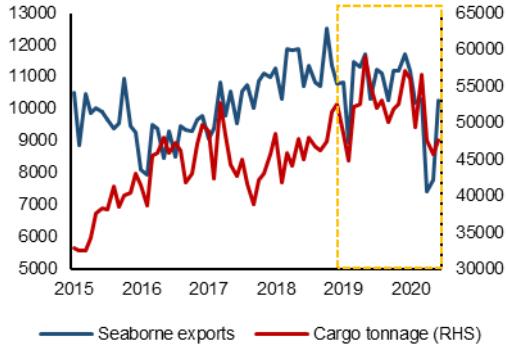
Period	Correlation coefficient
2015-2020	14%
2019-2020	63% ***

ASEAN-5: Indonesia



Period	Correlation coefficient
2015-2020	61% ***
2019-2020	75% ***

ASEAN-5: Malaysia



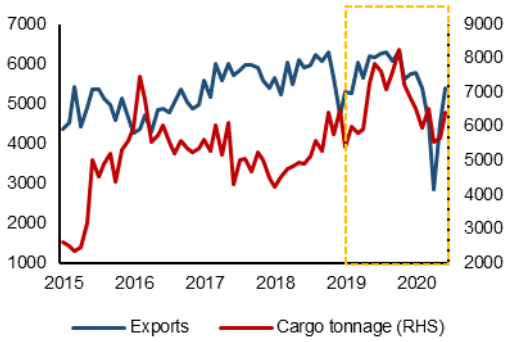
Period	Correlation coefficient
2015-2020	38% ***
2019-2020	70% ***

Note: Only seaborne exports are included.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

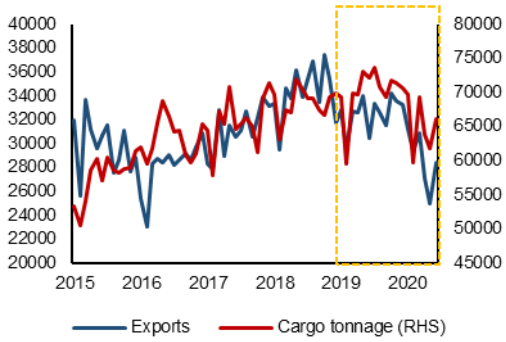
Appendix Figure 6 (Cont'd). ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Cargo Tonnage
(Millions of US dollars; thousands of tons)

ASEAN-5: Philippines



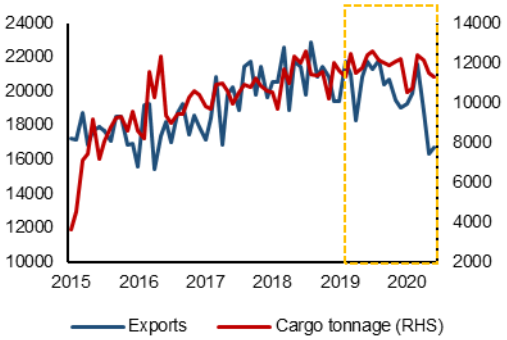
Period	Correlation coefficient
2015-2020	29% **
2019-2020	65% ***

ASEAN-5: Singapore



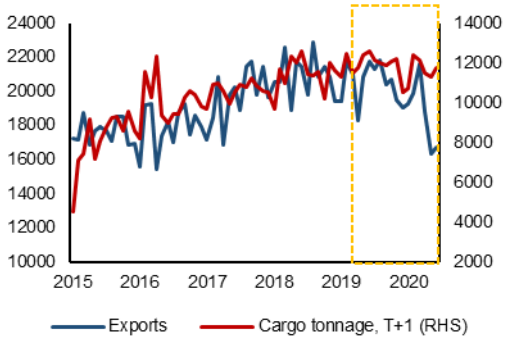
Period	Correlation coefficient
2015-2020	57% ***
2019-2020	79% ***

ASEAN-5: Thailand



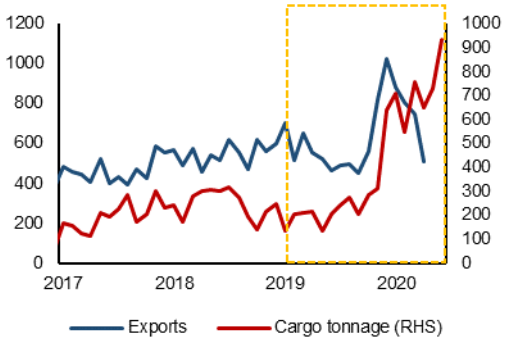
Period	Correlation coefficient
2015-2020	54% ***
2019-2020	44% *

ASEAN-5: Thailand *(adjusted)*



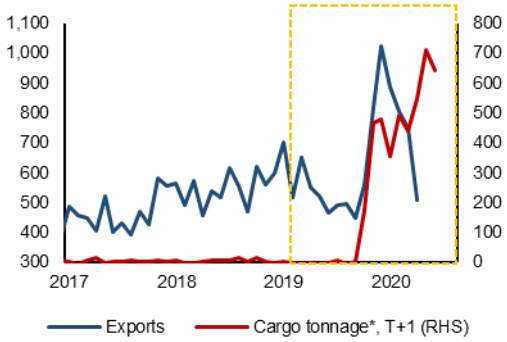
Period	Correlation coefficient
2015-2020	54% ***
2019-2020	54% *

BCMV: Brunei Darussalam



Period	Correlation coefficient
2015-2020	72% ***
2019-2020	62% ***

BCMV: Brunei Darussalam *(adjusted)*



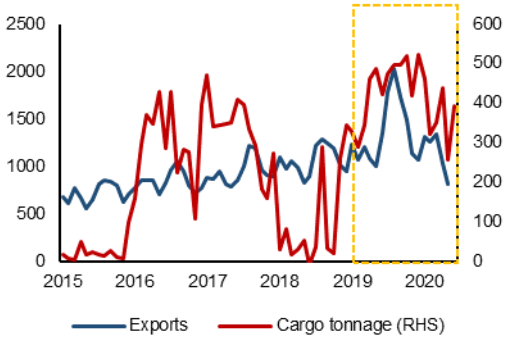
Period	Correlation coefficient
2015-2020	70% ***
2019-2020	68% ***

Note: Includes tankers vessel type only.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

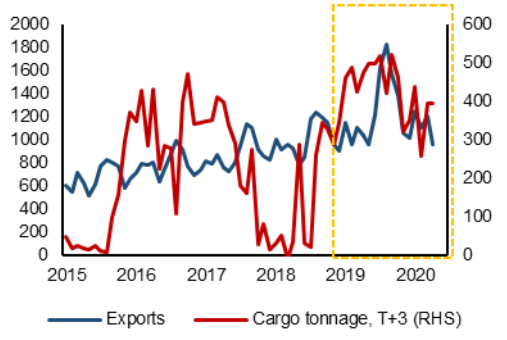
Appendix Figure 6 (Cont'd). ASEAN+3 excluding Lao PDR: Official Export Value Statistics and Cargo Tonnage
(Millions of US dollars; thousands of tons)

BCMV: Cambodia



Period	Correlation coefficient
2015-2020	49% ***
2019-2020	47% *

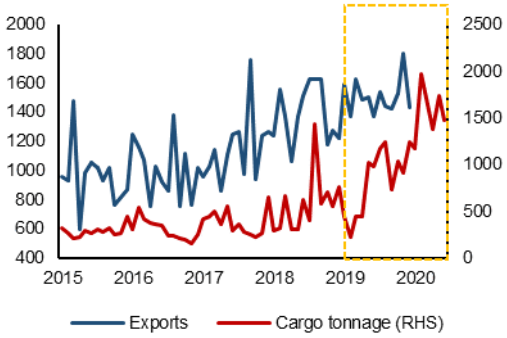
BCMV: Cambodia *(adjusted)*



Period	Correlation coefficient
2015-2020	43% ***
2019-2020	30%

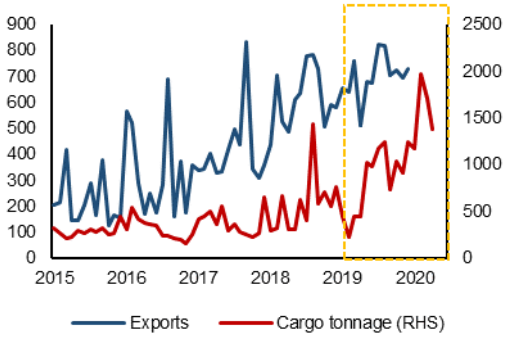
Note: Countries that share a land border with Cambodia (Lao PDR, Thailand, and Vietnam) are excluded from official exports.

BCMV: Myanmar



Period	Correlation coefficient
2015-2020	53% ***
2019-2020	-3%

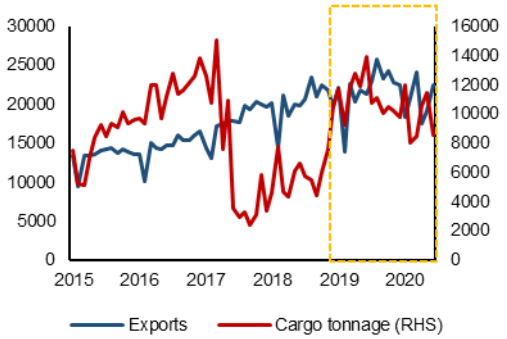
BCMV: Myanmar *(adjusted)*



Period	Correlation coefficient
2015-2020	61% ***
2019-2020	62% **

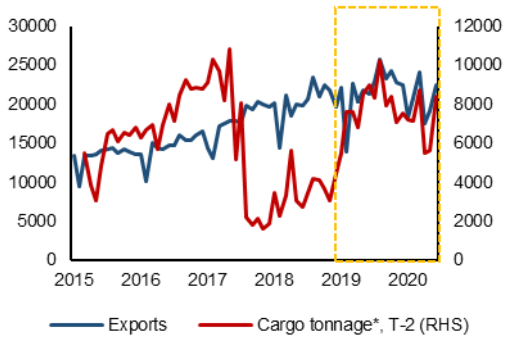
Note: Countries that share a land border with Myanmar (Thailand, Bangladesh, India, and China) are excluded from official exports.

BCMV: Vietnam



Period	Correlation coefficient
2015-2020	-10%
2019-2020	-3%

BCMV: Vietnam (adjusted)



Period	Correlation coefficient
2015-2020	-4%
2019-2020	54% **

Note: Includes containerships only.

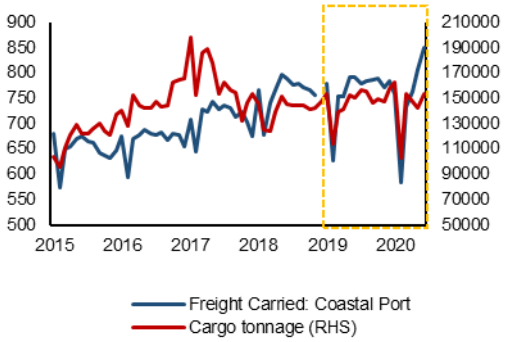
Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix IV. Comparing Official Export Volume Statistics against Shipping Indicators

Appendix Figure 7. Select ASEAN+3: Official Export Volume Statistics and Cargo Tonnage

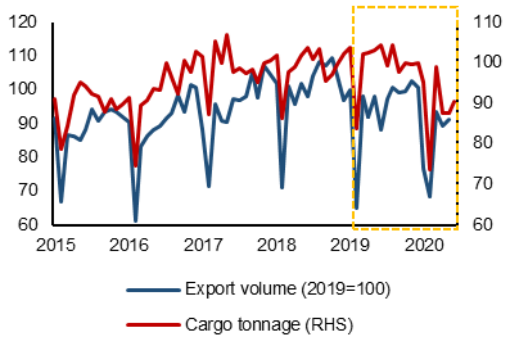
(2019 = 100 or tons; thousands of tons)

Plus-3: China



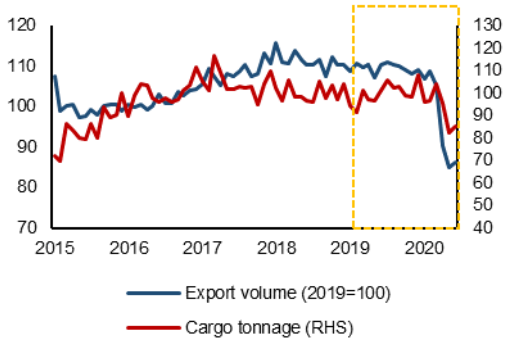
Period	Correlation coefficient
2015-2020	48% **
2019-2020	86% ***

Plus-3: Hong Kong, China



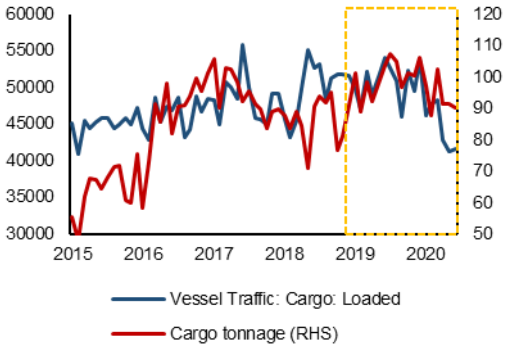
Period	Correlation coefficient
2015-2020	74% ***
2019-2020	78% ***

Plus-3: Japan



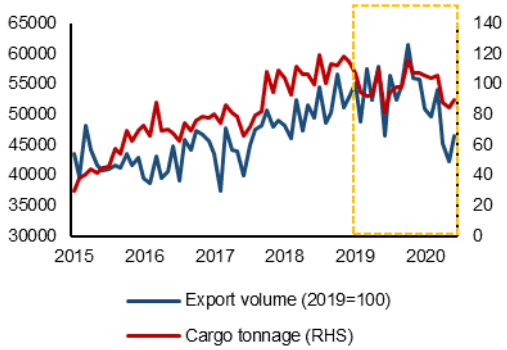
Period	Correlation coefficient
2015-2020	53% ***
2019-2020	73% ***

Plus-3: Korea



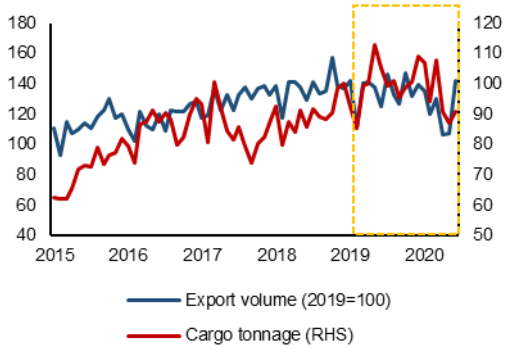
Period	Correlation coefficient
2015-2020	48% ***
2019-2020	75% ***

ASEAN-5: Indonesia



Period	Correlation coefficient
2015-2020	77% ***
2019-2020	76% ***

ASEAN-5: Malaysia



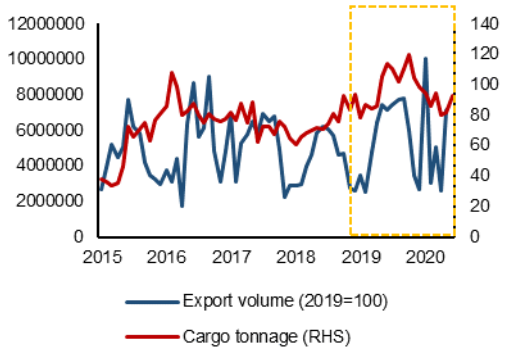
Period	Correlation coefficient
2015-2020	57% ***
2019-2020	50% **

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix Figure 7 (Cont'd). Select ASEAN+3: Official Export Volume Statistics and Cargo Tonnage

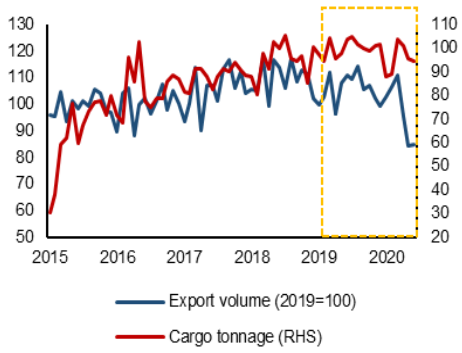
(2019 = 100 or tons; thousands of tons)

ASEAN-5: Philippines



Period	Correlation coefficient
2015-2020	25% **
2019-2020	40%

ASEAN-5: Thailand



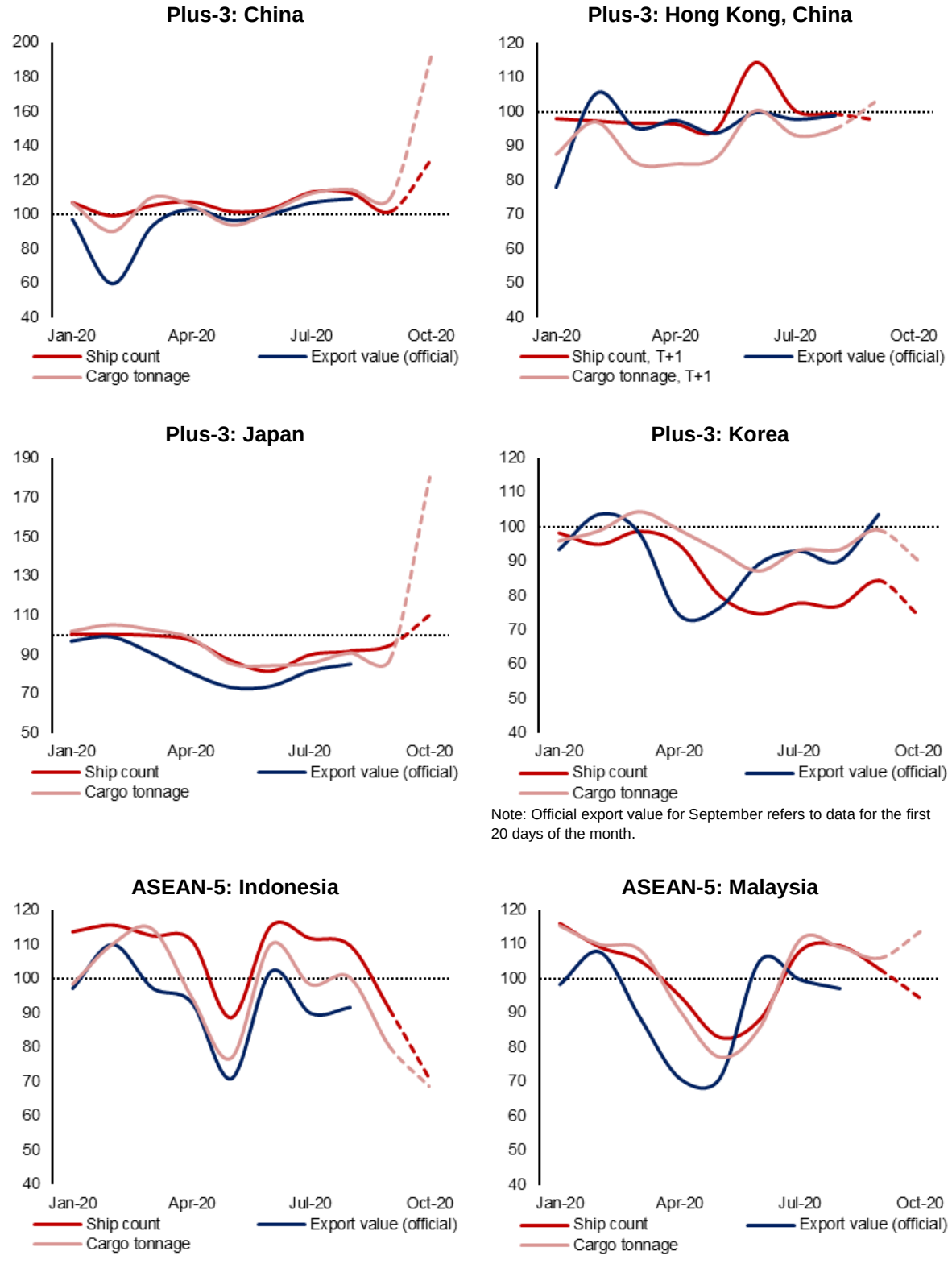
Period	Correlation coefficient
2015-2020	37% ***
2019-2020	41% *

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: ***, **, * represent 1 percent, 5 percent, and 10 percent level of significance, respectively.

Appendix V. Using Shipping Information as Leading Indicators of Exports

Appendix Figure 8. ASEAN+3 excluding Lao PDR: Forecasting Exports with Ship Count and Cargo Tonnage

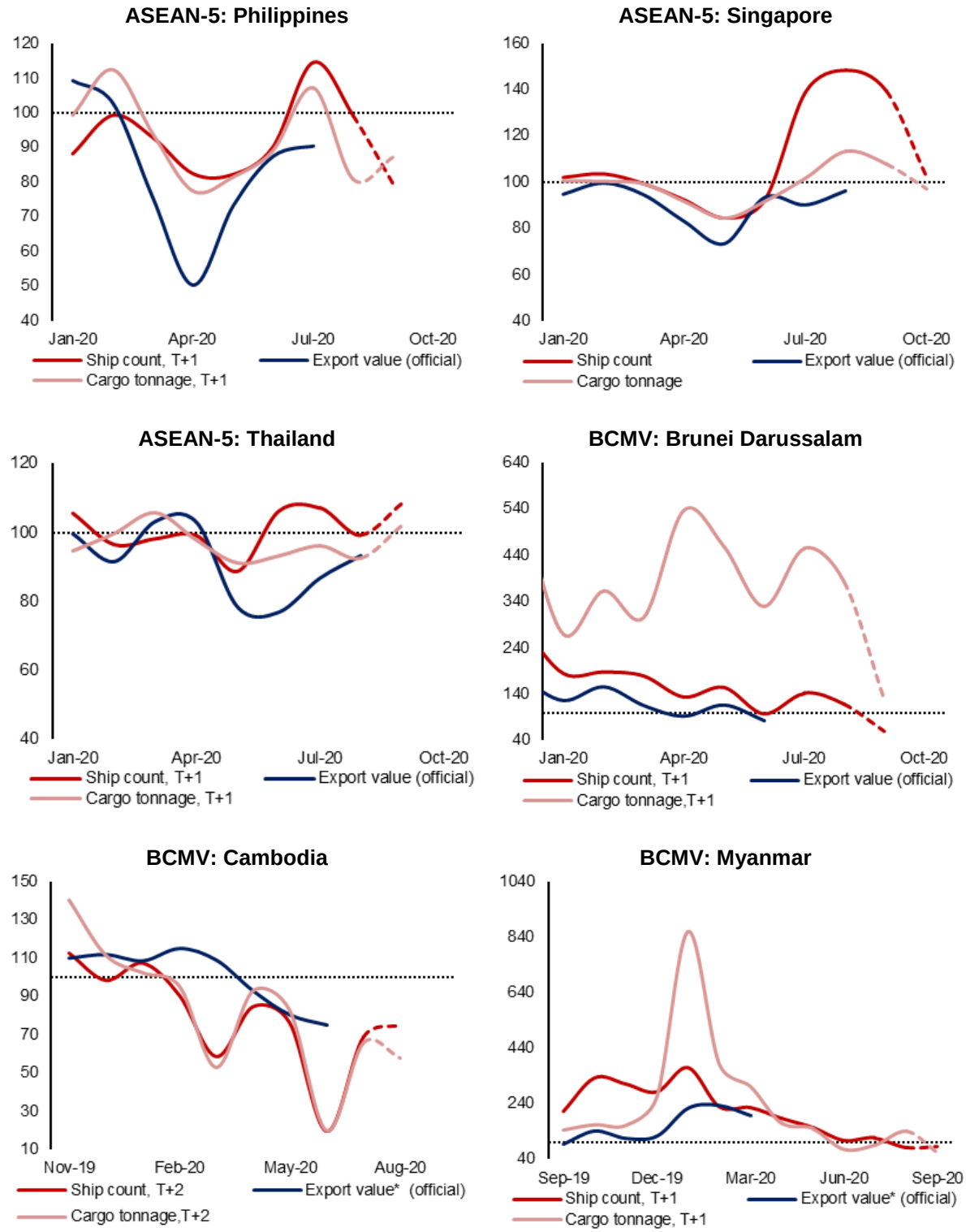
(Corresponding month in 2019 = 100)



Note: Official export value for September refers to data for the first 20 days of the month.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: October 2020 data for the AIS-derived indicators refer to the first 4 days of the month.

Appendix Figure 8 (Cont'd). ASEAN+3 excluding Lao PDR: Forecasting Exports with Ship Count and Cargo Tonnage
(Corresponding month in 2019 = 100)



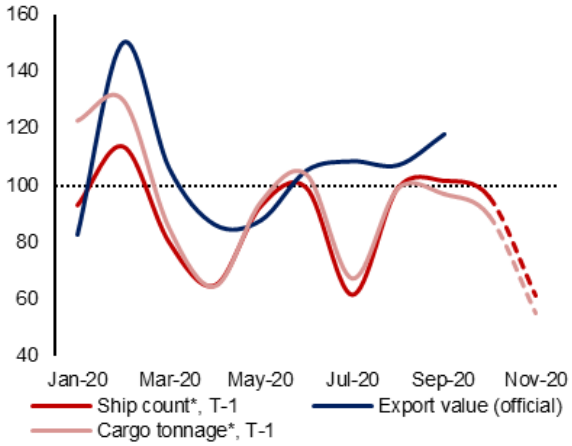
Note: Countries that share a land border with Cambodia (Laos, Thailand, and Vietnam) are excluded from official exports.

Note: Countries that share a land border with Myanmar (Thailand, Bangladesh, India, and China) are excluded from official exports.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: October 2020 data for the AIS-derived indicators refer to the first 4 days of the month.

Appendix Figure 8 (Cont'd). ASEAN+3 excluding Lao PDR: Forecasting Exports with Ship Count and Cargo Tonnage
(Corresponding month in 2019 = 100)

BCMV: Vietnam



Note: * refers to container ships only.

Sources: MarineTraffic; national authorities via Haver Analytics; and AMRO staff estimates.
Note: October 2020 data for the AIS-derived indicators refer to the first 4 days of the month.

References

Adland, Roar, Haiyang Jia, and Siri. P. Strandenes. 2017. “Are AIS-based Trade Volume Estimates Reliable? The Case of Crude Oil Exports.” *Maritime Policy & Management*, March, 1–9.

Arslanalp, Serkan, Marco Marini, and Patrizia Tumbarello. 2019. “Big Data on Vessel Traffic: Nowcasting Trade Flows in Real Time.” IMF Working Paper 19/275, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2019/12/13/Big-Data-on-Vessel-Traffic-Nowcasting-Trade-Flows-in-Real-Time-48837.

Cerdeiro, Diego, Andras Komaromi, Yang Liu, and Mamoon Saeed. 2020. “World Seaborne Trade in Real Time: A Proof of Concept for Building AIS-based Nowcasts from Scratch.” IMF Working Paper 20/57, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2020/05/14/World-Seaborne-Trade-in-Real-Time-A-Proof-of-Concept-for-Building-AIS-based-Nowcasts-from-49393.

Jia, Haiying, Vishnu Prakash, and Tristan Smith. 2019. “Estimating Vessel Payloads in Bulk Shipping using AIS Data.” *International Journal of Shipping and Transport Logistics* 11 (1): 25–40.

Rasid, Nur Raisah, and Shaoyu Guo. 2020. “Phase 1 Deal: EMAX’s Shine Does Not Fade.” Global Data Watch, JPMorgan Chase Bank, Singapore, August 21.

Singh, Vaninder. 2020. “Singapore—dbDIG-ing Daily Data for Exports.” Asia Economic Notes, Deutsche Bank AG, Hong Kong, February 21.

United Nations Conference on Trade and Development (UNCTAD). 2019. *Review of Maritime Transport 2019.* New York: United Nations. https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2563.

_____. 2018. *Review of Maritime Transport 2018.* New York: United Nations. https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2245.

Wong, Anthony. 2020. “Rocking the Boat with Alternative Data: Introducing the JPM BIDSI Trade Tracker.” Special Report, JP Morgan Securities, United Kingdom, February 20.