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Do Export Statistics Reflect Domestic Technological Capability? The Case of ASEAN

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Abstract: *There are solid theoretical grounds for an economy with growing technological capability to increase its high technology (high-tech) exports. The question that arises is whether the presence of high-tech exports also signifies technological capability. This paper examines the latter question in the context of the Association of Southeast Asian Nations (ASEAN) countries. Apart from Singapore, the Philippines and Malaysia have significant high-tech shares in manufacturing exports while Vietnam and Lao People's Democratic Republic (Lao PDR) have also seen their high-tech export shares rise. Domestic indicators of technological capability, however, show, at best, modest but also stagnant technological capability. This disconnect is explained by the high proportion of electronics exports by these countries as participants of global supply chains. Since a lot of the technology-embodied contents of these exports are also imported, reference only to gross exports overstates the domestic technology embodied in these exports and also gives an exaggerated impression of the exporter's technological capability. Opportunities, as well as challenges, exist in trying to bridge this gap.*

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1. Introduction

It has been argued on theoretical grounds that developing countries advance economically as a result of growing technological capability, with latecomers adopting various strategies to catch up with technologically advanced nations (Gershenkon, 1952; Abramovitz, 1956). This advance is concentrated in the manufacturing sector with its linkages to other sectors (Kaldor, 1967). In this process, not only will production embody more value-added but also more high-tech products will be exported. Lall (2000)

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outlined the broad strategies for boosting manufactured exports as "better exploitation of existing advantages (natural resources and unskilled or semi-skilled labour), (and) … the creation of new advantages (skills, technological capabilities, clusters and so on)". Noting that exploiting existing advantages is less demanding in terms of capabilities than the creation of new advantages, he nevertheless concluded that sustaining manufactured export growth requires the latter. Korea and Taiwan are poster boys for this growth strategy. Zhu and Fu (2013) using a cross country panel data set posited a similar set of determinants of export upgrading.

There are also arguments that with globalisation, trade liberalisation leads to technology upgrading. Furata (2015), studying Indian manufacturing firms, found exporters' total factor productivity increased when trade costs fell. However, more recently, countries further back in the development ladder have also seen their share of high-tech exports raise significantly. Bustos (2011) reached a similar conclusion in her study of Argentinean firms.

This paper focuses on technological capacity upgrading as a necessary condition for economic advance. That such upgrading is linked to global supply chains can be attributed to the prevalence of these chains and their potential as sources of technological advance among ASEAN countries.

Regardless of the direction of causation, it is expected that technology upgrading and the technological intensity of exports are closely linked. But doubts have been cast on this linkage. Given that there have not been stories of catch-up growth even remotely similar to those of Taiwan and Korea, the question naturally arises as to whether the positive data shown up in exports in countries like Malaysia represent no more than what Srholec (2005), quoting Lall, referred to as "a statistics illusion", it being argued that the workforce in developing countries are engaged in the labour-intensive parts of the international production chains. But all global supply chains are not the same. Kadarusman and Nadvi (2013) argue that just as there are opportunities for learning, there are also constraints and barriers to upgrading.

This paper looks at this domestic production and export link in the context of ASEAN, where technological capability varies considerably from country to country. To the extent the disconnect exists, it will attempt an explanation from the perspective of exports. There already exists substantial research on domestic constraints to technological upgrading (e.g. Kadarusman & Nadvi, 2013; Habaradas, 2009; Rasiah, 2010).

This paper is organised as follows. The next section looks at indicators of export technological intensity for ASEAN countries. Corresponding indicators of technological capability are presented and discussed in section 3. Section 4 attempts to explain the discrepancies in results reported in

sections 2 and 3. Section 5 concludes with drawing implications from these findings.

2. Technology Intensity of Exports

The most commonly used indicator of technology intensity in exports is the share of high technology exports in total manufacturing exports. Table 1 shows this intensity for ASEAN member countries for the period from 2010 – 2016.

Table 1: ASEAN: Share of high-tech exports in manufacturing goods exports, 2010-2016

Country/Year	2010	2012	2014	2016
Brunei	n.a.	12.8	7.8	17.9*
Cambodia	0.1	0.1	0.5	0.4
Indonesia	9.8	7.3	7.0	5.8
Lao PDR	6.6	8.7	24.9	33.6
Malaysia	44.5	43.7	43.9	43.9
Myanmar	0.0	1.0	0.6	7.6
Philippines	55.2	48.8	49.0	55.1
Singapore	49.9	45.3	47.2	67.4
Thailand	24.0	20.5	20.4	21.5
Vietnam	8.6	20.5	26.9	n.a.

Notes: *2015 value, n.a. = not available.
Source: United Nations (UN) COMTRADE database

Not unexpectedly, ASEAN member countries show a wide range of high-tech export shares, with Singapore, the Philippines and Malaysia having the highest shares. For the period, the Philippines' share topped Singapore's share except that for 2016, Singapore's share rose sharply to over 67%. Malaysia's share had remained a high 44% throughout the period. Thailand occupied the middle ground with a share of a little over 20%. Vietnam has seen its share of high-tech exports rise to overtake Thailand in 2014. Also of interest is the case of Lao PDR, which saw its high-tech share soar from below 10% up to 2012 to 25% in 2014 to 34% in 2016. Resource exporters Brunei, Indonesia, and Myanmar have the lowest shares of high-tech exports.

The categories classified as high-tech exports are aerospace equipment, computers, electronic products, electrical and non-electrical machinery, pharmaceuticals, scientific instruments, chemicals, and armaments. Of the three ASEAN countries with the highest share of high-tech exports in manufacture exports – Malaysia, the Philippines and Singapore – electronics and computers make up the bulk of high-tech exports (Table 2). Electronics constituted 61% of Malaysia's high-tech exports in 2010; this share rising to 74% by 2016. For the Philippines, this share rose from 61% to 69%, while Singapore's share remained steady at over 70%. Together with computers, they account for around 90% of high-tech exports. This pattern of exports

reflects the fact that these countries are participants of global supply chains in computers and electronics which have also become a mainstay of their manufacturing sector.

Table 2 also shows the ratio of the share of high-tech exports to that of Electrical and Electronics (E&E) exports in manufacturing exports. Since the share of E&E exports is higher than that of high-tech exports, these ratios show the proportion of E&E exports that are considered high-tech. The table shows this proportion to be between 60% and 70% for Malaysia, the Philippines and Singapore, with this proportion rising above 70% for the Philippines in 2010 and 2016, and Singapore for 2016. The proportion has also risen for Vietnam, which is reaching parity with the above three countries. Indonesia's remains low at under 30%. Of importance here is that while practically all high-tech exports are E&E exports, not all E&E exports are high-tech.

Table 2: Selected ASEAN countries: High-tech export composition and share compared to electronics export share of manufacturing exports, 2010-2016

Country/Year	2010	2012	2014	2016
Share of electronics in high-tech exports				
Malaysia	61.0	66.8	73.3	74.0
Philippines	60.9	63.5	67.1	69.4
Singapore	74.5	71.4	73.9	72.2
Share of computers in high-tech exports				
Malaysia	29.1	20.4	14.6	12.1
Philippines	34.3	23.9	27.3	23.8
Singapore	74.5	71.4	73.9	72.2
Ratio of high-tech export share to E&E export share of Manufactured exports				
Indonesia	0.382	0.272	0.290	0.267
Malaysia	0.663	0.666	0.655	0.645
Philippines	0.792	0.690	0.691	0.734
Singapore	0.697	0.672	0.698	0.960
Thailand	0.515	0.472	0.464	0.464
Vietnam	0.363	0.524	0.628	0.491

Notes: No data for the other ASEAN countries.
Source: UN COMTRADE database

The significance of these exports would suggest a measure of comparative advantage for this sector in these countries. As shown in Table 3, revealed comparative advantage (RCA) coefficients for this sector are all greater than one for all countries except Indonesia, and considerably greater than one in Malaysia, the Philippines and Singapore, suggesting significant comparative disadvantage in these sectors. Vietnam is the only country exhibiting a rising trend in RCA coefficients. However, such results need to be interpreted with caution. RCAs implicitly assume arms-length trade which global supply chain-related trade is not. Since the decision to locate parts of the supply chain rests with multinationals, RCAs may reflect

Multinational Corporations' (MNCs) perceptions of a host country's comparative advantage in respect of that part of the supply chain that the MNCs intends to locate in a host country. This RCA would disappear once the MNCs decide to locate its production elsewhere.

Table 3: Selected ASEAN countries: Revealed comparative advantage coefficients for electronics, 2010-2016

Country/Year	2010	2012	2014	2016
Indonesia	0.37	0.36	0.35	0.34
Malaysia	1.63	1.53	1.50	1.54
Philippines	1.44	2.20	2.03	2.10
Singapore	1.85	1.77	1.75	1.83
Thailand	1.20	1.17	1.20	1.13
Vietnam	0.54	1.02	1.18	1.34

Source: Authors' estimates

3. Indicators of Domestice Technological Capability

Are these positive figures for the intensity of high-tech exports reflective of considerable or growing domestic technological capabilities in these countries? To answer this question requires a review of indicators of domestic technological capability. These indicators are broadly of two types. The first consists of country-level indicators compiled by different organisations under alternative auspices. These indicators of technological capability can be sub-indicators that are aggregated to become a macroeconomic indicator of, say, competitiveness. The second deals with specific characteristics evidencing or attributes of technological capability.

Of the former, one is the Technological Readiness Sub-Index that is a component of the Global Competitiveness Index of the World Economic Forum. Data for the technological readiness sub-index show that outside of Singapore, which is ranked in the top deciles of over 100 countries, all other ASEAN countries do relatively poorly (Table 4). Malaysia, despite the high intensity of high-tech exports, is the next most highly ranked, at just below rank 40. The Philippines, the other big-hitter of high-tech exports, ranks in the bottom half of countries, and, since 2015/6, has been ranked below Thailand. More worrying is the fact that no country has seen its ranking improve between 2011/12 and 2017/18.

The Global Competitiveness Index also has a sub-index for innovation (Pillar 12). Made up of seven indicators, it measures both the capacity for and the implementation of innovation. Using this sub-index, the picture did not change very much, although several countries (Indonesia, Lao PDR, and Malaysia) saw their country ranking for innovation significantly higher than their ranking for technological readiness, signalling the need to improve capability so that actual innovation can be more effectively used.

Table 4: ASEAN: Country ranks of technological readiness sub-index, 2011-2018

Country/Year	2011/2	2013/4	2015/6	2017/8
Brunei	57	71	n.a.	60
Cambodia	110	97	105	97
Indonesia	94	75	85	80
Lao PDR	n.a.	113	119	110
Malaysia	44	61	47	46
Myanmar	n.a.	148	138	n.a.
Philippines	83	77	68	83
Singapore	10	7	5	14
Thailand	84	78	58	61
Vietnam	79	102	92	79
Total no. of countries	142	148	140	137

Notes: n.a. = not available.
Source: World Economic Forum (WEF) Global Competitiveness Report 2011-12, 2013-14, 2015-16, 2017-18

Table 5: ASEAN: Country ranks of innovation sub-index, 2011-2018

Country/Year	2011/2	2013/4	2015/6	2017/8
Brunei	68	59	n.a.	80
Cambodia	85	91	122	110
Indonesia	36	33	30	31
Lao PDR	n.a.	68	108	81
Malaysia	24	25	20	22
Myanmar	n.a.	143	132	n.a.
Philippines	108	69	48	65
Singapore	8	9	9	9
Thailand	54	66	57	50
Vietnam	66	76	73	71
Total no. of countries	142	148	140	137

Source: WEF Global Competitiveness Report, 2011-12, 2013-14, 2015-16, 2017-18

The picture is somewhat more optimistic when perusing the share of medium and high-tech manufacturing value-added in total manufacturing value-added (Table 6). Here, Malaysia, the Philippines and Thailand all have shares above 40%, with Vietnam joining the group in 2015. Singapore is the standout at over 80%. To the extent this pattern depicts production in global supply chains and is consistent with that portrayed by exports, it does not say much about technological capability.

Other indicators portraying specific attributes of technological capability, specifically Research and Development (R&D) expenditure as % of Gross Domestic Product (GDP) and patent applications, reveal much the same story as that emerging from the macro-indicators described above. Table 7 shows ASEAN countries expenditure as percentages of their respective GDPs, benchmarked against the newly industrialised economies of Korea and Taiwan, as well as China as the emerging science and technology powerhouse.

Table 6: ASEAN: Share of medium- & high-tech manufacturing value-added in total manufacturing, 2010 & 2015

Country/Year	2010	2015
Brunei	3.32	3.32
Cambodia	0.26	0.26
Indonesia	40.3	35.1
Lao PDR	n.a.	n.a.
Malaysia	42.6	42.6
Myanmar	11.6	6.6
Philippines	45.7	46.0
Singapore	84.8	80.4
Thailand	43.8	40.7
Vietnam	25.4	40.4

Notes: n.a. = not available

Source: United Nations Industrial Development Organisation (UNIDO): Industrial Development Report, 2018, Annex B3

Table 7: ASEAN and selected East Asian economies: R&D expenditure as % of GDP, 2010-2015

Country/Year	2010	2012	2014	2015
Brunei	n.a.	n.a.	n.a.	n.a.
Cambodia	n.a.	n.a.	n.a.	0.1
Indonesia	0.1 (2009)	n.a.	0.1 (2013)	n.a.
Malaysia	1.0	1.1	1.3	1.3
Philippines	0.1 (2009)	0.1 (2011)	0.1 (2013)	n.a.
Singapore	2.0	2.0	2.2	n.a.
Thailand	0.2 (2009)	0.4 (2011)	0.5	0.6
Vietnam	n.a.	0.2 (2011)	0.4 (2013)	n.a.
Lao PDR	n.a.	n.a.	n.a.	n.a.
Myanmar	n.a.	n.a.	n.a.	n.a.
China	1.7	1.9	2.0	2.1
South Korea	3.5	4.0	4.3	4.2
Taiwan	2.8	3.0	3.0	3.0

Notes: n.a. = not available

Source: World Development Indicators; OECD

The picture is far from reassuring. Leaving aside Singapore and the resource exporting countries, only Malaysia spends 1% or more of its GDP on R&D. Thailand spends about half that share in 2015 while Vietnam has also increased its share but from a very low base. The Philippines spends minimally (0.1%) on R&D. These proportions are far less than the minimum of 2% which advanced countries spend on R&D to stay at the frontier of technology. China, although not yet an advanced country, has achieved that percentage by 2014, while Korea's and Taiwan's R&D spending exceed that threshold by quite a margin.

The situation is not much better with patent applications for ASEAN countries except Singapore (Table 8). While the number of patents applied for increased between 2010 and 2016 for Indonesia and Vietnam, numbers have remained negligible. Also modest are the numbers for the other ASEAN countries, with the Philippines' applications numbering fewer even than

Vietnam's. The number of applications has also remained flat in Malaysia and Thailand. Singapore tops the number of applications in 2016, well above Malaysia and Thailand. Furthermore, with 286 patents applications per million populations in 2016, Singapore is the only country in the global top 20. It is ranked 16th, behind China with 874 applications and ranked 6th, Japan with 2,049 applications and ranked second, and Korea with 3,189 applications and ranked first (World Intellectual Property Organisation (WIPO) Indicators 2017, Table A42: 71).

Table 8: ASEAN: Patent applications by residents, 2010-2016

Country/Year	2010	2012	2014	2016
Indonesia	508	--	702	1,058 (2015)
Malaysia	1,231	1,114	1,353	1,109
Philippines	170	162	334	327
Singapore	895	1,081	1,303	1,601
Thailand	1,214	1,020	1,006	1,098
Vietnam	306	382	487	560

Notes: No data for Cambodia, Lao PDR, Myanmar.
Source: World Bank database, from WIPO data

All in all, the domestic data reveals that outside Singapore, technological capability remains a challenge for ASEAN countries. There is no successor to Korea and Taiwan and no prospect of one emerging. There is thus a significant discrepancy between what these indicators and those based on trade show.

4. Explaining the Discrepancy

How can this discrepancy be explained? It is clear that the share of high-tech exports shown earlier has much to do with global supply chains in electronics locating in these countries (Gangnes & Van Assche, 2010). These chains are controlled by MNCs, which locate production of parts of the chain in a country which possesses a comparative advantage in that segment of production. Host countries have limited leverage over which segment of the supply chain they host, and likewise the technology embodied in that segment. For ASEAN countries except Singapore, their comparative advantage is still defined by their relatively low labour costs rather than technological sophistication (HKTDC, 2017).

The intensive participation of ASEAN countries in these chains can be shown by high estimated values of the Grubel Lloyd Index, the most commonly used indicator of intra-industry trade (IIT) (Table 9). The proximity of the index to the value 1 signifies extensive intra-industry trade while an index value close to zero implies that almost all trade is between different firms. Since the index is calculated as the magnitude of IIT divided by total trade, it can be interpreted as the share of IIT in total trade.

Table 9: Selected ASEAN countries: Grubel Lloyd IIT indices for electronics and electrical goods, 2011-2018

Country/Year	2011/2	2013/4	2015/6	2017/8
Indonesia	0.61	0.53	0.55	0.55
Malaysia	0.92	0.93	0.92	0.90
Philippines	0.92	0.87	0.77	0.98
Singapore	0.87	0.89	0.87	0.87
Thailand	0.96	0.93	0.99	0.99
Vietnam	0.65	0.90	0.94	0.99

Source: Authors' estimates

Table 9 shows the overwhelming importance of IIT in the ASEAN countries with major E&E exports, the sole exception being Indonesia. Starting with an IIT index closer to Indonesia, Vietnam quickly caught up with its other ASEAN neighbours. It has been argued that with the exception of Singapore and possibly Malaysia, the location of supply chains in Southeast Asia is often to take advantage of low-cost labour in host countries. Labour intensive (relative to other parts of the supply chain) assembly is what host countries specialise in. The finding from Table 2 that not all E&E exports are high-tech attests to the reality that ASEAN countries occupy the lowest parts of the value chain in E&E production and do not generate much value-added in this process. In this situation, the transfer of technology is also likely to be limited. It is therefore highly plausible for low domestic technological capability to be compatible with relatively high technology-intensive exports.

This still leaves open the question of the source of the exports' technological intensity. If indeed assembly operations are the work undertaken, then not much value is added to the products in these chains. One way to test this is to determine the value-added of electronics exports. An alternative, though less precise, is to review the value of net exports, i.e. exports minus imports of the same product, in this case, E&E. This is shown in Table 10.

Table 10: Selected ASEAN countries: Net exports of E&E as % of manufactured exports, 2010-2016

Year	2010		2012		2014		2016	
Country	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Indonesia	25.6	-33.1	26.8	-46.7	24.1	-39.9	21.7	-36.0
Malaysia	67.1	9.9	65.6	8.6	67.0	9.7	68.1	12.0
Philippines	69.7	-12.3	70.7	15.8	70.9	26.1	75.0	3.1
Singapore	71.6	15.9	67.4	13.3	67.6	15.2	70.2	15.9
Thailand	46.6	3.2	43.4	-6.8	44.0	0.5	45.3	1.1
Vietnam	23.7	-25.8	39.1	-9.0	42.8	-5.0	49.1	-1.3

Source: UN COMTRADE Database

Table 10 shows the wide disparity between gross export and net export values. Of particular significance are the figures for countries which host

global supply chains and for which E&E count as their major manufactured exports. These are currently, Malaysia, the Philippines and Singapore, and in the near future Vietnam. For these countries, from shares of gross exports in manufactured exports of around 70%, the net export share of manufactured exports is reduced to less than a quarter of the gross export share. This translates into high import content for these countries' E&E exports.

A more direct way to visualise the domestic contribution of E&E exports is to calculate the value-added of these exports. While such data are unavailable for ASEAN countries, the modest values of net exports suggest that such value-added should be modest. Further, the technology intensity of E&E exports has most certainly originated from imports.

5. Conclusion

From a national perspective, a comparison between trade indicators of export performance and domestic indicators of technological capability shows an apparent disconnect between them – the technological intensity of manufactured exports is not reflected in indicators of domestic technological capability. The source of the former phenomenon has been shown to be countries' hosting global supply chains.

This participation has benefited ASEAN countries to the extent it contributes to export earnings and provides employment, as well as a degree of stability in exports except in times of global recession. However, it is also hostage to decisions made by MNCs over which the host country has no say. As shown here, it has done precious little to upgrade domestic technological capability. Participation in, global supply chains is thus no guarantee of technological upgrading unless a degree of technology transfer can be accomplished through such participation. This has generally not happened for ASEAN countries which participate in supply chain activities that garner low value-added, such as assembly operations. The reasons for the lack of domestic technological capability have been well researched. They relate more to domestic constraints than to trade issues; despite the arguments made that trade liberalisation promotes productivity growth. Key among these domestic constraints is the inadequacy of human capital, both quantitative and qualitative. As an example, for Malaysia which has achieved universal primary education, the common laments are of a shortage of students in the hard sciences and "unemployable graduates".

The inability to strengthen technological capability may mean falling into the so-called "middle-income trap" (Gill & Kharas, 2007). This "trap", the result of a middle-income country's inability to upgrade its technology to challenge more advanced countries even as its labour cost advantage is being progressively eroded by countries lower down but moving up the

development ladder, has been a matter of concern among policy-makers from China to Vietnam.

For sectors with global chains, gross exports overstate the actual value of exports contributed by the country since import content is also counted as exports. Alternative measures, such as export value-added, give a much better picture of a country's export performance. This is also material in the calculation of measures like revealed comparative advantage.

From the perspective of the future of supply chains, these chains are an integral part of the globalisation process – the growth of intra-Asian trade owes much to the expansion of these networks in this part of the world (HKTDC, 2017). But globalisation is under threat, and the protectionist sentiment is on the rise in the US (United States), and in response to the US posture, in Europe. This will have negative consequences for the operations of these global supply chains. As the 2008-2009 Global Financial Crisis showed, market downturns in America and Europe could cause severe disruptions in supply chains (Gangnes & Van Assche, 2010). The ongoing trade dispute between the US and China is also putting pressure on MNCs to locate their supply chains out of China. This is easier said than done, and even if achievable, will entail significant cost increases, some of which will be passed on to final consumers of products.

On the positive side, the gradual shift not only of supply chains but also of markets to Asia affords ASEAN countries' MNCs the opportunity to establish their supply chains and for these chains to engage in higher value-added activities (Oizumi, 2013). While the possibilities for technology transfer are higher, the primary source of technological capability is still domestic and countries need to develop this capability domestically.

For supply chains irrespective of ownership, issues are emerging that require attention among MNCs. These include timeliness to market, flexibility to vary output in response to changing market conditions, and responsiveness to customer needs, all of which in response to the rise of e-commerce, especially in China (Tsang, Boutot, Guarraia, & Athanassiou, 2015). These considerations are likely to lead to a reconfiguration of supply chains as some ASEAN countries begin to lose their labour cost advantage. For these countries especially, but even for ASEAN member countries as a whole, the need to upgrade technological capability is imperative.

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