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Measuring the total factor productivity for international seaport in South East Asia (ASEAN)

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Abstract

Aim: The goal of this paper is to quantify the contribution of ports to GDP in three different nations. Singapore's port, Malaysia's Bintulu port, and Thailand's Leamchabang port are the ASEAN ports examined in this paper.
Methodology: Cargo throughput (tons) is the output variable, and the four inputs (ship count, vessel handled capacity (DWT: Dead Weight Tonnage), number of employees per terminal, and terminal area) are all described in the published data (m2). The weighted aggregative technique is used to construct inputs and outputs data details.
Findings: Progress in port efficiency in Singapore, Malaysia, and Thailand is demonstrated by the findings. Singapore's port is the most productive of the three and has the least disruption to throughput (TFP).
Novelty/Implications: While trade and maritime transport cooperation between Korea and ASEAN has been strengthened, little research has been conducted on analyzing container port efficiency in ASEAN. Since this is the first study of its kind in ASEAN, it can be considered the beginning of port studies in the region. Based on these findings, we can select candidate cities and nations for a port cooperation initiative on a global scale.

Keywords: ASEAN Ports, Färe-Primont TFP Index, Scale and Mix Efficiency

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INTRODUCTION

A port can be considered a "engine" for regional economic growth because it boosts the number of jobs, the number of people working in the region, the amount of money made by local businesses, and the taxes collected from residents. These advantages result from the port building (or expansion) and maintenance. To ensure the highest quality result, local builders and laborers are utilized, and building supplies are sourced locally. Port operators (shippers and ocean and inland carriers) and other service providers (ship agents, ship repairs, freight forwarders, marine insurers, pilots, and towage service providers), among others, all play a role in the smooth running of the port (Ducruet 2009; Ago and Yang 2015).

Improving port activity in ASEAN is possible thanks to Singapore, Thailand, and Malaysia, which provide the highest export and import values in ASEAN (World Bank 2014). Because of this, the total maritime productivity of each port is the primary focus of this paper.

Because of the region's geography, ASEAN's supply chain networks can benefit most from using maritime transport routes. Given its strategic location and well-developed port infrastructure, ASEAN continues to serve as a major hub for the movement of goods. Despite their geographical location, the primary shipping lanes include ASEAN countries with prominent roles in the global economic and professional systems (Shie 2006; Wu 2016).

The value of goods traded within ASEAN in 2015 was $608.3 billion, representing 24.1% of total trade in the region. Inter-ASEAN investment was $19.1 billion, or 17.9 percent of the total FDI in ASEAN. The AEC (ASEAN Economic Community) leaders are optimistic that the current upswing in trade and investment will continue. As of 2015, the region's total GDP was $2.57 trillion, with an average GDP per capita of $4,135 billion, nearly double the figures from 2010. However, Southeast Asia, including the AEC countries, is at a logistical crossroads due to the increasing demand for high-tech, energy-efficient real estate facilities to accommodate the

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region's increasingly complex supply chains, driven by modernization and economic factors (Burnson 2016).

Research Objectives

The purpose of this study is to compare the Total Factor Productivity of three major ASEAN ports (Thailand, Malaysia, and Singapore).

Three major ASEAN ports serving international shipping will be compared (Thailand, Malaysia, and Singapore).

Scope of the Study

Based on annual cargo and container throughput statistics, this research considered the Total Factor Productivity of the three busiest ASEAN international ports in Thailand, Malaysia, and Singapore. We focused on the years 2007-2015 for this analysis. Cargo throughput (tons) is the output variable, and the four inputs, ship count, vessel handled capacity (DWT: Dead Weight Tonnage), number of workers per terminal (m^2), and terminal area (m^2), are the sources of information for secondary data analysis. Since many studies assess the various sizes and types of ports, the inputs and outputs data are constructed using a weighted aggregative method.

LITERATURE REVIEW

The following indicate literature on port efficiency using Data Envelopment Analysis (DEA). Ha (2003) investigated the efficiency of 35 ports in the USA and North-East Asia from 2005 to 2007 through Creedence Clearwater Revival (CCR) and BCC analysis. Park (2010) analyzed the effectiveness from claiming 45 ports for East Asia, Europe, and North America. Enter components incorporate the amount for berth, aggregate compartment length, container yard (CY) size, and the number of cranes. Output factor includes twenty-foot equivalent units (TEUs) and the number of shipping liners to boat calls. In addition, Park (2010) proposed the effectiveness of 11 compartment terminals to transshipment including Busan and Kwangwang ports. Enter elements for example; container yard (CY) size, the amounts for holder crane, the amount of yard crane, and the amount of yard tractor were utilized. It designated the number from transshipment TEU (Twenty-Foot Equivalent Unit) as a yield component for exploring the effectiveness. Roll and Hayuth (1993) evaluated ports in created nations utilizing Creedence Clearwater Revival (CCR) model in (DEA) basically keeping tabs ahead a hypothetical investigation as opposed to genuine provision since no data were analyzed. They contributed to firstly employing Creedence Clearwater Revival (CCR) model, based on constant returns to scale, in the maritime and port sector. Notteboom, Coeck, and Van Den Broeck (2000) verified the efficiency of 36 terminals in European ports through Bayesian Stochastic Frontier Model and likewise analyzed 4 terminals in Asia for A benchmark. They utilized compartment length, terminal size, and a number of cranes as input variables along with TEU (Twenty-Foot Equivalent Unit). Likewise, for an output variable, they contended that each compartment terminal's most extreme effectiveness can't exceed 0. 85.

The advantage of model transportation is to boost the discriminatory power by dynamically increasing the total number of DMUs so that it is easier to track port performance and stability over time. Chudasama (2009) investigated sources of the inefficiency of port authorities of 12 ports in India, which is an emerging market, adopting both DEA-CCR and DEA-BCC. Cheon, Dowall, and Song (2009) discovered that worldwide port upgrades and R&D might need an impact ahead degrees of container ports starting from 1991 to 2004. They identified both effectiveness transforms and the reason of efficiency fluctuation by translating Malmquist productivity index, and contended following. First, they have seen economies of scale similarly as an important element without unconditional power. Second, because of worldwide competition, it is possible for ports to overcome external weakness by changing governance and increasing capital. Third, hostility venture with respect to R&D scarcely assumes a vital part of port rivalry because of simple imitability. Munisamy and Singh (2011) theory following efficiency analysis began with the works of Koopmans (1951), Debreu (1951), and Farrell (1957) who made the first attempts at estimating efficiencies for a set of observed production units.

It has been found that size of sea-port has positive effects on its efficiency. Also, it has been shown that ports with larger throughput seem to have a certain performance advantage over those with smaller throughput. In Kennedy et al. (2011), research on 15 sea-ports showed that port efficiency has no clear relationship with its size and function (hub or feeder). Relative experiment from Jajri (2007) showed that export growth rate also positively influences the TFP growth. As export grows, the higher will be the TFP growth. This is presumably because of the pressure from international competition and benefits of economies of scale. This shift from domestic market dependence to production for export market will necessitate firms to venture into large-scale operations and increase production capacity in order to enjoy the benefits of economies of scale. Large-scale production will induce greater utilization of technology and skilled manpower and through these, efficiency and productivity enhancements will be obtained that will bring about lower unit costs of production. Seo, Ryoo, and Aye (2012) in their conclusion of the study contribute to the following Asian aspects. Firstly, acquiring ports' data in ASEAN is quite difficult since there is little data port authorities published and they are reluctant to disclose it.

Nonetheless, this study manages to obtain data from a direct contact with port authority in Myanmar, academics in Thailand, and so forth as well as Korea government reports. Secondly, inefficient ports can improve their port facilities and port performance by benchmarking DMUs, which have similar structure and size. In general, ASEAN ports have low port efficiency except for a few ports such as Singapore port, port of Tanjung Pelepas, and Port of Kota Kinabalu. Therefore, in order to improve maritime transport networks as a whole in ASEAN, for example, a port that has low levels of efficiency should benchmark efficient DMUs. This leads to the facts that inefficient ports can plan to develop by benchmarking efficient ports as a blueprint for their future. Thirdly, port managers are capable of improving port operations according to information of slacks without constructing new port facilities. Fourthly, from the perspective of Korea, these results can be utilized to determine potential ports and countries for an international port development co-operation programmed such as ODA with Korea by referencing objective data in order to help ASEAN to achieve better port networks by developing the infrastructures of ill-equipped ports. Lastly, to authors' best knowledge, there is little research on analyzing container port efficiency in ASEAN, while co-operation of the trade and maritime transport between Korea and ASEAN has been strengthened. Therefore, the current study can be viewed as the outset of port research in ASEAN.

Table 1: Summary of involvement

Author	Variables		Target Area
	Inputs	Outputs	
Tongzon (2009)	-Number of cranes -Number of container berths -Number of tugs -Delay time -labor	-TEU -Ship working rate	4 Australian & other 12 international ports
Rios and Macada (2006)	-The number of cranes -Berth length -The number of employees -The number of yard equipment -CY size	-TEU Average number of containers per hour per ship	23 MERCOSUR ports
Al-Eraqi et al. (2007)	-Berth length -Storage area -Handling equipment	-TEU -Ship calls	22 ports in the Middle East and East Africa
Jajri (2007)	-capital per GDP -Total factor productivity growth -Export + Import per GDP or trade ratio to GDP	TFP growth	Malaysia over the 1970-2004
Park (2010)	-Number of berth -Total berth length -CY size -Number of cranes -Depth	-TEU -Ship calls	45 ports in East Asia, Europe, and North America

Table 1: Conti....

Author	Variables: Inputs	Variables: Outputs	Target Area
Park (2010)	-CY size -Number of container crane -Number of yard crane -Number of yard tractor	-Number of transshipment	11 terminals in Busan & Kwangwang port
Wu and Goh (2010)	-Terminal area -Total quay length -pieces of equipment -Berth length (m) -Terminal Area (m^2)	-TEU	22 ports in BRIC, the Next-11, and G7
Munisamy and Singh (2011)	-Total Refer Points -Total Quayside Cranes -Total Yard Equipment	-Total Throughput (TEU)	71 major Asian container (2007)
Kennedy et al. (2011)	-Quay Length (km) -Terminal Area (hectares) -No. of Quay cranes	-Total Throughput (TEU)	5 Asia port
Seo et al. (2012)	-Number of Berths -Berth Length -Total Area	TEU	ASEAN port

Conceptual Framework / Model

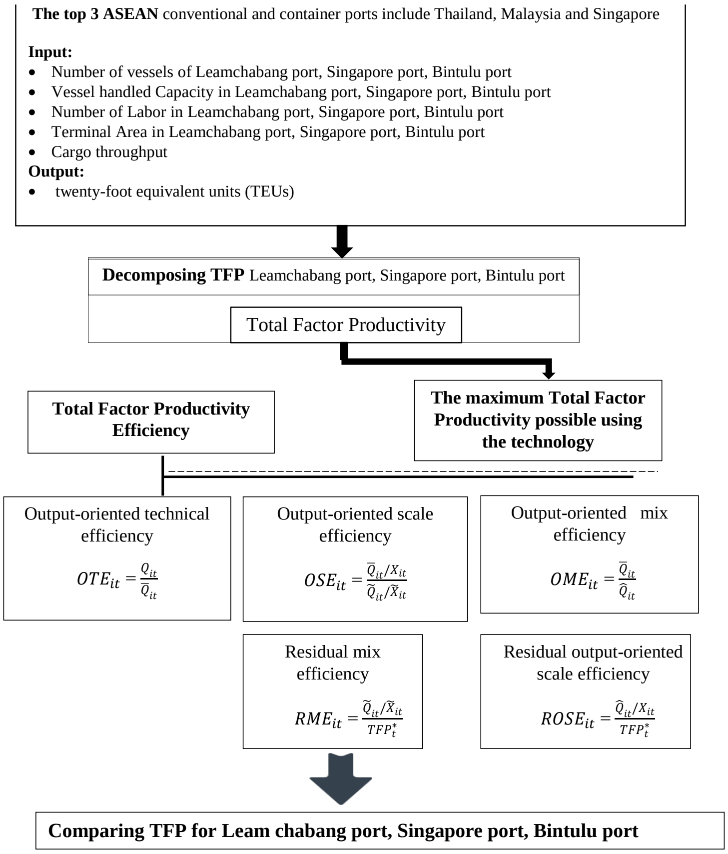

Figure 1. Conceptual framework

METHODOLOGY

A measure of the change in TFP can be defined as the ratio of outputs over inputs. Let x_{it} = Number of vessels$_{it}$, Vessel handled capacity$_{it}$, Labor$_{it}$, Terminal area$_{it}$, Cargo throughput$_{it}$ and q$_{it}$ = TEUs$_{it}$ denote the input and output quantity of i = Leamchabang port, Singapore port, Bintulu port in period t from 2007 to 2015; TFP is defined as

$$TFP_{it} = \frac{Q_{it}}{x_{it}} \qquad \text{Total factor productivity} \tag{1}$$

Where Q_{it} = $Q(q_{it})$ is an aggregate output in Leamchabang port, and Singapore port, Bintulu port. X_{it} = $X(x_{it})$ is an aggregate input in Leamchabang port, Singapore port, Bintulu port and Q(.) and X(.) are non-negative, non-decreasing and linearly homogenous aggregator function (O'Donnell 2011).

To make it more delicate, let's consider a set of Leamchabang port, Singapore port, and Bintulu port in this study that is the set of time of each port in a period from 2007 to 2015. With this definition, the index number that measures the TFP of i = Leamchabang port, Singapore port, and Bintulu port in period t relative to another port h in period s is:

$$TFP_{hs,it} = \frac{TFP_{it}}{TFP_{hs}} = \frac{Q_{it}/X_{it}}{Q_{hs}/X_{hs}} = \frac{Q_{hs,it}}{X_{hs,it}} \qquad \text{TFP index} \tag{2}$$

Where $Q_{hs,it} = Q_{it}/Q_{hs}$ is an output quantity index and $X_{hs,it} = X_{hs}/X_{it}$ is an input quantity index. O'Donnell, Rao, and Battese (2008) referred to TFP indices that can be expressed in terms of aggregate quantities as being multiplicatively-complete.

There are several ways to decompose TFP efficiency. The easiest way to decompose TFP indices is to rewrite equation $TFP_{it} = TFP_t^* \times TFPE_{it}$ for Leamchabang port, Singapore port, and Bintulu port = i in period t = 2007 to 2015. It follows that

$$TFPE_{it} = \frac{TFP_{it}}{TFP_t^*} \qquad \text{TFP efficiency} \tag{3}$$

Where TFP_t^* is the maximum possible TFP using the technology available in period t from 2007 to 2015. Hence, TFP efficiency is a measure of overall productive performance.

The measures of efficiency denote from O'Donnell (2010) that can be written as follows:

$$TFPE_{it} = OTE_{it} \times OME_{it} \times ROSE_{it} \tag{4}$$

$$TFPE_{it} = OTE_{it} \times OSE_{it} \times RME_{it} \tag{5}$$

$$\text{Where } OSME_{it} = OME_{it} \times ROSE_{it} = OSE_{it} \times RME_{it} \tag{6}$$

More detail of equation (4), (5), and (6) can be found in O'Donnell (2010). Alternatively, TFP efficiency could write the previous expression as follows:

$$TFPE_{it} = OTE_{it} \times OSME_{it} \tag{7}$$

When substituting equation (7) in (3), total factor productivity of i in period t from 2007 to 2015 is:

$$TFP_{it} = TFP_t^* \times (OTE_{it} \times OSME_{it}) \tag{8}$$

Finally, the index that compares the TFP of Leamchabang port, Singapore port, and Bintulu port = i in period t = 2007 to 2015 with the TFP of port h in period s can be written as:

$$TFP_{hs,it} = \frac{TFP_{it}}{TFP_{hs}} = \left(\frac{TFP_t^*}{TFP_s^*}\right)\left(\frac{OTE_{it}}{OTE_{hs}}\right)\left(\frac{OSME_{it}}{OSME_{hs}}\right) \tag{9}$$

While TFP_t^*/TFP_s^* measures the change in the maximum possible TFP using the technology available in period s and t, which is a technical change, OTE_{it}/OTE_{hs} and $OSME_{it}/OSME_{hs}$

RESULTS AND DISCUSSION

Index number and theoretically underpinning a percentage of the commonly-used index number formulae might have been utilized for analyzing those mechanics from claiming contacting value. Furthermore, the amount index number nearly TFP progress will measure benefit transforms, index numbers are used in determining changes in the levels of outputs created and the levels of inputs used in the creation progression over two time periods or across two firms. The concentration of this segment is to define the computational procedures used in deriving an index of TFP either over time or across firms or enterprises. A TFP index may be applied as follows:

Table 2: Singapore port

Year	TFP	TFP*	TFP Change	TFPE	OTE	OSE	OME	ROSE	OSME
2007	1.1627	1.1627	0.9748	1	1	1	1	1	1
2008	1.1927	1.1927	1	1	1	1	1	1	1
2009	1.1685	1.1927	0.9797	0.9797	1	1	1	0.9797	0.9797
2010	1.1885	1.1927	0.9965	0.9965	1	1	1	0.9965	0.9965
2011	1.2189	1.2189	1.0219	1	1	1	1	1	1
2012	1.1966	1.2189	1.0032	0.9817	1	1	1	0.9817	0.9817
2013	1.2241	1.2241	1.0263	1	1	1	1	1	1
2014	1.2398	1.2398	1.0394	1	1	1	1	1	1
2015	1.2153	1.2398	1.0189	0.9802	1	1	1	0.9802	0.9802
Average	1.200	1.209	1.0067	0.9931	1	1	1	0.9931	0.9931

TFP efficiency (TFPE) is a measure of overall productive performance as described in Table 1 indicating that this measure gave an average of 0.993122 which means that Singapore port in 2007 2015 fell shortly about 0.01 percent on average according to port activity and transshipment. In detail, there is a little bit fall in 2009 (0.13 percent), 2010 (0.01 percent), 2012 (0.02 percent), and 2015 (0.02%).

The number of falls in detail and overall does not have significance that we can indicate activity of this port as not efficient for 9 years. However, the number of 0.9931 is quite high and close to 100 percent of efficiency in Singapore port. The outcome of TFPE illustrates that port of Singapore shows a high potential to run business steadily. We can put all outcomes into graph to look how steady the TFPE of port in Singapore is.

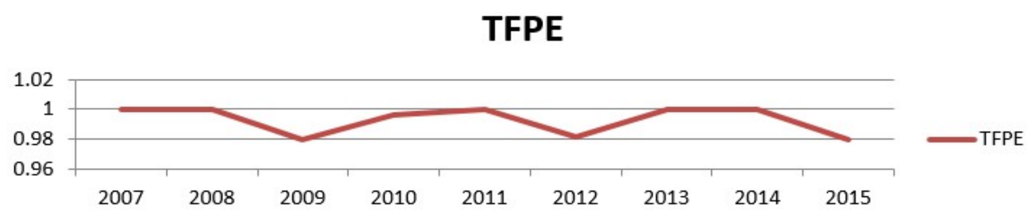

Figure 2. TFPE of Singapore port in 2007-2015

The TFPE graph shows the number of TFPE did not fall below 0.98. The value is swinging between 1 and 0.98; it means that this port constrains performance of port work to handle all ships and cargo in port very well.

Once TFPE is further decomposed into OTE and OSME, the estimates indicate that OTE almost equals to 1.0 and, in particular, equals 1.0 for all states in both 1990 and 2011. Other studies have calculated OTE to find most values that are equal to 1.0 or at least very close. This is suggested that pure technical efficiency is commonly achieved.

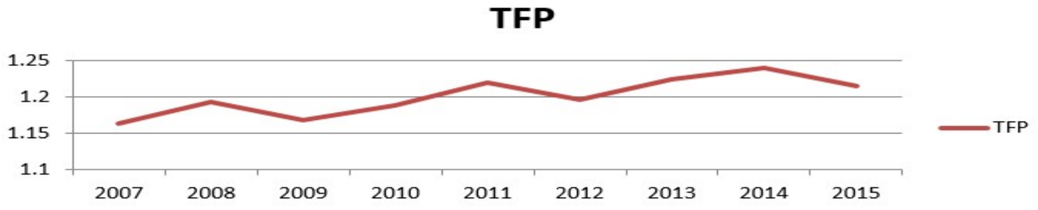

Figure 3. TFP of Singapore port in 2007-2015

The lowest point of TFP in the graph was observed in Singapore port in 2007. TFP between 2008 and 2009 had been increased when compared with 2007. However, TFP value in each year is fluctuated. The average efficiency goes higher but in detail, the Singapore port has changed almost year by year significantly. Since the number of TFP showing the efficiency of port decreases or increases, we can define that Singapore port is a better one because they run business efficiently every year.

Table 3: Malaysia (Bintulu port)

Years	TFP	TFP*	TFP Change	TFPE	OTE	OSE	OME	ROSE	OSME
2007	0.3485	1.1627	0.2922	0.2997	1	1	1	0.2997	0.2997
2008	0.3154	1.1927	0.2644	0.2644	1	1	1	0.2644	0.2644
2009	0.3065	1.1927	0.257	0.257	1	1	1	0.257	0.257
2010	0.3241	1.1927	0.2717	0.2717	1	0.9919	1	0.2717	0.2717
2011	0.3383	1.2189	0.2836	0.2775	1	0.9549	1	0.2775	0.2775
2012	0.3386	1.2189	0.2839	0.2778	1	0.9471	1	0.2778	0.2778
2013	0.366	1.2241	0.3069	0.299	1	1	1	0.299	0.299
2014	0.3627	1.2398	0.3041	0.2926	1	1	1	0.2926	0.2926
2015	0.3666	1.2398	0.3074	0.2957	1	1	1	0.2957	0.2957
Average	0.3407	1.2091	0.2856	0.2817	1	0.9882	1	0.2817	0.2817

TFP efficiency (TFPE) is a measure of overall productive as described in Table 2. TFP average of Bintulu Port is 0.34 meaning that Bintulu Port in 2007 2015 increased about 0.02 when compared with 2007 on average.

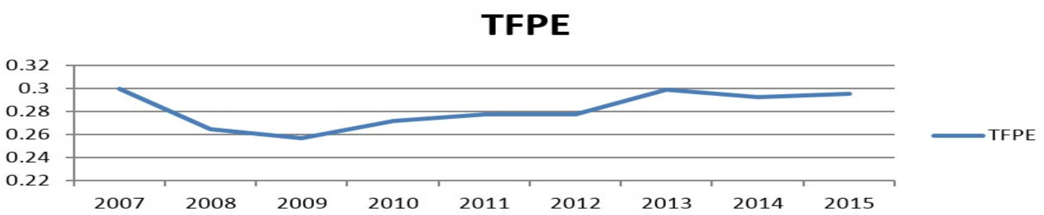

Figure 4. TFPE of Bintulu Port in 2007-2015

According to the graph in 2007 which is the highest TFPE (∼0.3), TFPE had fallen until 2009 with about 0.25 percent of efficiency. TFPE was increased to 0.2717 in 2010. Moreover, TFPE was gradually increased between 2011 and 2013 and slowed down the growth in 2014.

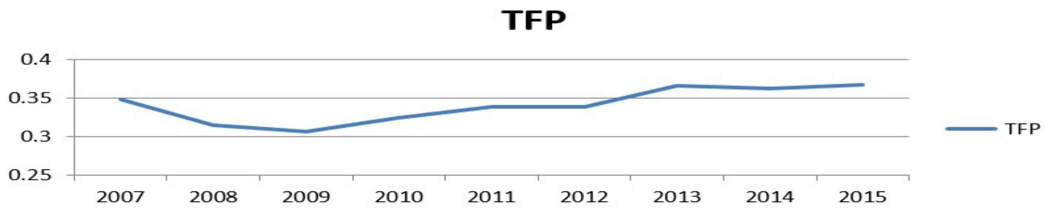

Figure 5. TFP of Bintulu Port in 2007-2015

TFP of Broadacres Bintulu port as illustrated in figure 4. The figure uncovers a few critical insights about the Bintulu port for the example time. First, the benefit and effectiveness levels of the port have fluctuated extensively over the test periods. It reveals to a, generally speaking, expanding example about gainfulness from 2009 to 2012. Then it starts to increase and continues until 2013 and then starts to fall again.

TFP change and its components of technological change and productivity change start at years 2007 with about 29 percent of efficiency and then decrease until 2009 since the world economy in lowest point is 25.7. After that, the port improves efficiency. This implies that TFP in 2010 to 2015 continues increasing and then reaches the highest point in the year 2015 about 30.74.

Table 4: Thailand (Leamchabang port)

Years	TFP	TFP*	TFP Change	TFPE	OTE	OSE	OME	ROSE	OSME
2007	0.3618	1.1627	0.3033	0.3112	1	1	1	0.3112	0.3112
2008	0.5392	1.1927	0.4521	0.4521	1	1	1	0.4521	0.4521
2009	0.5005	1.1927	0.4196	0.4196	1	1	1	0.4196	0.4196
2010	0.4893	1.1927	0.4102	0.4102	0.9732	1	1	0.4215	0.4215
2011	0.4491	1.2189	0.3765	0.3685	1	1	1	0.3685	0.3685
2012	0.3899	1.2189	0.3269	0.3199	0.8403	1	1	0.3807	0.3807
2013	0.3434	1.2241	0.2879	0.2805	0.7085	1	1	0.3959	0.3959
2014	0.3217	1.2398	0.2697	0.2595	0.6442	1	1	0.4028	0.4028
2015	0.3222	1.2398	0.2701	0.2599	0.6989	0.987	1	0.3719	0.3719
Average	0.4130	1.2091	0.3463	0.3424	0.8739	0.9986	1.0000	0.3916	0.3916

Table 4 presents the meta-technology Färe-Primont productivity change index and its components in each year during 2007-2015 of Leamchabang port.

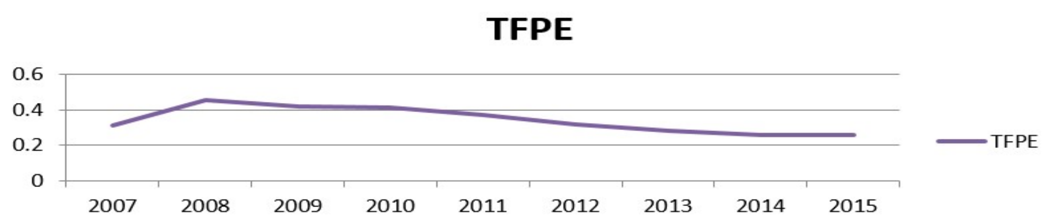

Figure 6. TFPE of Leamchabang port in 2007-2015

Using these efficiency measures, one can describe TFP efficiency (TFPE), which is the proportion between watched benefit and the most extreme gainfulness in the table demonstrating to produce effectiveness.; the first year in table is 2007 starting at 0.3112 percent; then moving to the highest point in the next year is 0.4521 percent. After that, the number of TFPE shows that efficiency of TFP decreases gradually every year and reaches the lowest point at about 0.26 in 2014 and 2015.

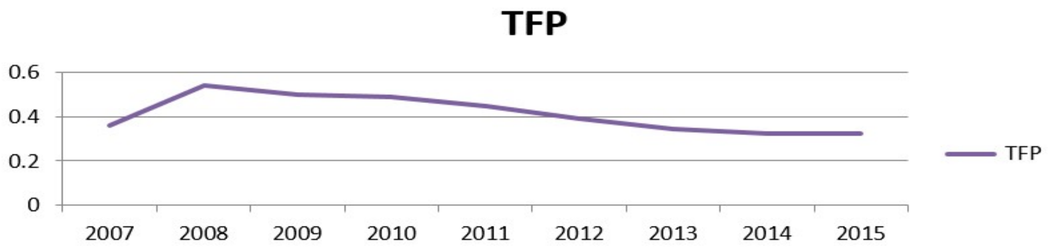

Figure 7. TFP of Leamchabang port in 2007-2015

The measurement of TFP growth is performed using Färe-Primont Productivity Index developed by O'Donnell (2010, 2012). This is a relatively new index-based method for measuring productivity change. O'Donnell (2012) proposes an estimation approach which meets every last one of needed axioms for gainfulness list measurement. In this way, the Färe-Primont advantage index from claiming O'Donnell (2012) is sorted similarly as A 'multiplicatively complete' benefit index. Then the result of TFP in port of Leamchabang starts at 0.303 percent in 2007 and then increases to the highest point in 2008 to about 0.4521 percent and then percent of TFP declines gradually every year.

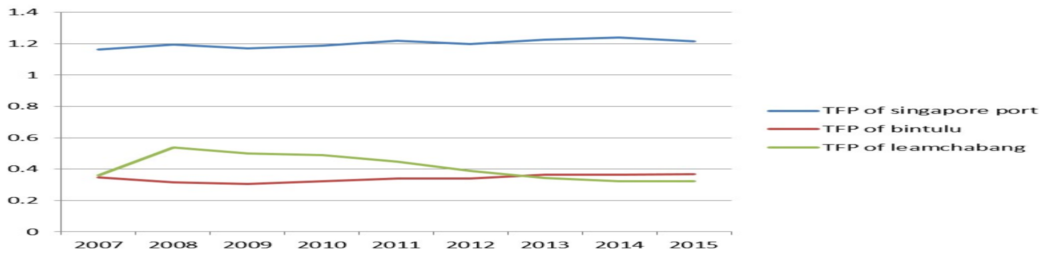

Figure 8. Compare TFP of three ports in 2007-2015

When thinking about TFP of three ports, we concern those study periods finalized alongside 2007 to 2015. The progress for TFP from claiming three ports will be a Contrast. However, Singapore needs an immense contrast in the middle of Bintulu Port and Leamchabang port. Previously, aggregate element gainfulness was used for measuring effectiveness. Those TFPs for Bintulu port and Leamchabang port transform in the hole the middle of 0.45 and 0.25; yet all the Singapore ports on normal from claiming TFP are practically 100 that is a considerable measure of distinction of TFP. Effectiveness table demonstrating TFP will be ascertained utilizing the Färe-Primont list and disintegrating it under different measures for effectiveness change (technical, scale, and mix efficiency). Also specialized foul progress of Singapore and the r may be a considerable measure clinched alongside measuring effectiveness.

Discussion

This part will start at Singapore port outcome that shows in graph and table that Singapore port does business very efficiently and constantly. Look back in the first place Singapore has come a long way possible to get to its change starting with a small fishing village to today's worldwide center port and universal oceanic focus throughout the span from claiming its urban advancement journey. The Frameworks placed to set up permitted sea industry to weather storms, for example, the global financial crisis and rival starting with regional ports. The timely development of port infrastructure and transportation networks for backing those businesses spurred for perusing containerization might have been a key contributing factor. In 2015, those improvements of the country's port and associated transport infrastructure were supported and backed by heavy economic considerations and needed substantial effects on the city's improvement.

However, as containerizations condensed of age warehouses and offices about facilities use, there might have been a great deal. The coordinated effort between the port power and urban organizers together with the private segment will redevelop these ranges for more stupendous livability outcomes, which were seen over territories along the Singapore River. The port will proceed with a chance to be a major part of Singapore's economy. The challenge setting off ahead may be how to support its constant growth. Previously, Singapore as the place contending for utilization of those restricted add up from claiming land will be getting tighter, and the call for a livable city stronger (Maritime and Port Authority of Singapore 2014). But Singapore has planned to build the third and fourth phases of the Pasir Panjang terminal that will be opened at completely operational by end-2017. The terminal will permit Singapore to handle 50m TEUs yearly. Those longer-term wants will be on shift port exercises far from Tanjong Pagar and Pasir Panjang, will Tuas. The Tuas ports will provide a chance to be produced in four periods through 30 quite some time. When completed, it will have those abilities to handle 65m TEUs from claiming holders annually; alternately more than twice measure from claiming TEUs took care in 2015. Singapore arrangements move constantly on its port exercises on Tuas from 2027. And only the government's arranging will be allowed up prime sea-facing land to Tanjong Pagar and Pasir Panjang to private and business developments (EIU Solutions 2016).

Bintulu Port and Leamchabang port are not different in efficiency of port and handling activity but Leamchabang port is more efficient than Bintulu port by a tiny proportion because Bintulu port in geographically arranged halfway the middle of Kuching, Sarawak, and Kota Kinabalu, Sabah along those occupied ocean lanes for Intra Asia exchange for a profound ocean harbor. Bintulu Port is the import and fare passage to Sarawak and the Brunei, Indonesia, Malaysia, Philippines, and East ASEAN development region (BIMP-EAGA) locale. Today, it is East Malaysia's biggest compartment port and the nation's sole condensed characteristic gas (LNG) fare passage and it may be noted as at present a standout amongst those biggest LNG fare terminals in the reality. Freight produced from its hinterland is anticipated to expand. Likewise, the Sarawak hall for renewable vitality (SCORE) activities would implement, for extra shipment of aluminum, mash and paper, silicon, manganese, fertilizer, downstream timber, and agro produce. Also, result settling on its route of the dock. More than three-quarters of Malaysia's total land is open to maritime water and this geographical landscape justifies the importance of the maritime industry for the nation's economic growth. With a geographical advantage, the maritime industry in Malaysia has been extremely important since the 1970s (Economic Planning Unit 1976). This is evident from the volume of cargo handled increasing from 23.1 million tonnes in 1980 to 539 million tons in 2010 (Economic Planning Unit 2011). The major seaports in Malaysia include Port Klang, Penang Port, Johor Port including PTP, Kuantan Port, and Bintulu Port. Others such as Lumut Port, Sabah Port, Kuching Port, Rajang Port, and Miri Port are regional seaports (MIMA 2015). These seaports underpin Malaysia's economy by connecting the maritime network and the inland transport system. That is why when subprime crisis happens, it has the effect on the price of oil and LNG that make the efficiency of port fall down in that year and this port is near an Oil rig in Bintulu town; it made the port to be very sensitive to gas price situation. However, this port is located at busy sea lanes of Intra-Asia Trade with a deep sea harbor and the only deep sea harbor in Borneo Island; then they can improve the efficiency of the port by improving technology and new strategy (Chen, Jeevan, and Cahoon 2016).

Also, Leamchabang port, the geological area from claiming Thailand is fortified with neighboring nations, for example, Myanmar, Laos, Cambodia, moreover Malaysia and likewise need the entry to China and Vietnam. It is concerning about illustration of a passage on South East Asia location. It needs favorable element for its substantial hinterland; therefore, those ports need those helter-skelter abilities to make a passage port to the neighboring nations for making its hinterland (Pongpanich and Peng 2016). Laemchabang port needs the current state-of-art foundation and hi-technology offices should back at administrations. It may be fit for taking care of biggest vessels (Post-Panamax). It needs additional supporting ranges for docking operations and related exercises. Moreover, those ports are nerved. Eventually Tom's perusing those organizations of highways, railways, and waterways; interfacing both the places and neighboring countries. Additionally, Laemchabang port needs additional regions for augmenting related benefits of the business such as truck couch terminals, appropriation center, organized commerce area, so on and so forth. This also incorporates other vital offices for example, the unsafe bulks warehouse and shoot harm aversion focal point. These offices need aid affirmed to the worldwide standard with being prepared to furnish constantly on benefits. Then port can handle a lot of vessels, cargo, and cargo throughout and technology is still the key to development (Thai 2016).

Overall, the best port in this work is Singapore port. Second and third cannot identify clearly because the average TFP of Leamchabang port is more than Bintulu port but if we take a look at the trend of TFP, Bintulu Port trend is increased nevertheless while the trend of Leamchabang is decreasing in year that concerns from 2007 to 2015.

Suggestions

Asia's port scene will be an unbelievable element at the moment and 2017 will be quite a while about noteworthy transforms concerning illustration of structural alterations in the liner shipping segment and shifts in the financial make-up of the locale that keeps on developing. Long haul geopolitical arranging by Asia's major forces is in turn power variable crashing dynamism in the division across those regions. Concerning illustration of a long haul key exertion Toward Singapore will 'lock-in' benefits of the business to nature's domain for greater alliances and a more united industry; this will be a story on watch in 2017. Including intensely the dynamism for port action previously, Southeast Asia, those ends from claiming 2016 saw a staggering publication by China that it might have been contributing USD1. 9 billion will raise another port on the Malacca Strait. From an ability and business perspective, those need a truly new improvement in the occupied waterway that is doubtful and the move may be a solid instance about how the extent for geopolitics camwood eclipse advertises the business constraints in port advancement (Liang et al. 2011).

Furthermore, Issues that are related to ports' improvement in ASEAN or suggestions for three ports (Xiao, Lam, and Li 2017) are as follows:

- Structural transforms in the industry, especially combination and the arrangement from claiming bigger and that's only the tip for more powerful alliances.
- Proceeding deluge about mega-vessels also ensuring prerequisite to upgrade infrastructure and equipment.
- Long-term arranging of Singapore on modifying port to the most recent time; it shows limit duty to lines also alliances, and techniques utilized by 'lock-in' enormous union clients.
- Extension of fare manufacturing parts in the region, especially Vietnam and Myanmar.

And event that port will set the plan to adaptation and set the direction of strategy to come along with the trend of ASEAN port in 2017 (Xia, Lam and Li, 2017).

- Lock-in of collusion movement and volumes by larger facilities, for example, Singapore and conceivably Colombo and the effect of this looking into different transshipment hubs in the district.
- The likelihood of littler passage ports getting less direct calls but more feeder traffic as the larger alliances prefer to serve them through bigger alliances like with serving them through greater hubs that offer more terrific levels from increased box return.

Shipping lines, like the railways, bring customarily furnished provided for the level of administration to an extensive amount of shippers. Containerizations encouraged intermodal transport and enabled shipping lines with the table administrations to also start with inland destinations. However, those levels about administration were even now as situated. Down clinched alongside a distributed schedule, besides (generally not minus) remittances could reasonably be expected for postponements. Moved forward data frameworks bring enabled shippers to be finer educated around the place cargoes regarding conveyance dated at progress those way for administration offerings (Gwartney et al. 2016).

This exploring of the different components of productivity growth in this study provides important information to policy makers on what policy measures need to be adopted to escape from the recent productivity slowdown in Bintulu port and Leamchabang port after subprime crisis. The declining technical progress warrants a government policymaking in improving production about port service. State-level variations in scale and mix efficiency suggest on efficient use of port resources in production in Thailand and Malaysia. However, this study has a lack of not exploring the main drivers of a technical downturn that need to be further investigated in future research (Gwartney et al. 2016).

Limitations

Limitation of this research is to collect data since it is quite hard to collect all and correctly. For example, the number of labor of each of the ports is a big problem of this work because ports in Thailand and Malaysia were not willing to reveal the data in this part and technology of each port is quite hard to estimate, too.

Consequently, this work used program DPIN 3.0 to estimate the variables that concern and set up for estimate output (cargo throughout) by depending on input about port activity that is number of vessel, vessel handle capacity, labor, and Terminal area; but those variables are not all of the variables that affected the port efficiency because other factors are hard to collect and confirm correctly to include to be one of the variables in this work.

CONCLUSION, RECOMMENDATIONS AND IMPLICATIONS

The objective of this article is to assess productivity change in ASEAN port during 2007-2015, namely TFP change and its components technological change and efficiency change. For this, we used the economically ideal FarePrimont index which verifies the multiplicative completeness property and is also transitive, allowing for multi-temporal/lateral comparisons. To compare the technology gap change between the six types of port considered, we extended the Färe-Primont to the meta-frontier framework.

The results are showing the progress of the port efficiency in Singapore, Malaysia, and Thailand. The chosen ports are Singapore port, Biutulu port, and Leamchabang port taking a look at each of the ports in detail. First port is Singapore. Singapore port is very efficient in progress of port activity, the TFP efficiency (TFPE) on average is about 0.9931 percent; it means Singapore port handles port activity very efficiently and controls stability of efficiency though economic crisis in 2008 by only 0.3 decrease in the year 2009 and then TFP efficiency increased close to 1 again. TFP of Singapore port runs very efficiently as well; on average, TFP is about 1.0067 percent which is over 100 percent of efficiency, the Färe-Primont estimates of actual TFP, maximum TFP, and TFP efficiency and their relative changes. The following is Leamchabang port having efficiency higher than Bintulu port by 0.4 and 0.34 in order. The outcome of last two ports is not different; it means they can improve and develop ports in many ways such as being competitive to other countries, improving technology which is the key to development according to Max TFP, etc. If Leamchabang port and Bintulu port can improve technology, then port performance will increase.

Build infrastructure to connect the port or relate the port activity and encourage government to realize that they have a chance to expand maritime transport is crucial.

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