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# Aspects Affecting Total Factor Productivity in the Maritime Economic Sector: Analysis from a Long Coastline Nation

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*ABSTRACT*

Total Factor Productivity (TFP) plays an essential role in the economic development of every nation. Moreover, recommendations from TFP analysis for any economic sector at the firm level may help researchers and policymakers to obtain a better view of the sector. With a long coastline, the maritime sector, including seaports, warehousing and logistics, has become a promising industry since Vietnam's integration. Using a panel-data model with different data sources, this research shows that the local GDP growth rate positively impacts the productivity of enterprises in the maritime sector and the productivity of the whole industry. Other variables such as access to land, accessibility of information, time cost, proactivity of provincial leadership, and labour and training also significantly impact the productivity of this industry. In addition, the larger enterprises are, the higher the productivity they obtain. Finally, both import and export activities are significantly positive for the maritime economy's productivity.

## 1. Introduction.

Total Factor Productivity (TFP) is considered a driver for economic development. TFP explains the efficiency of an industry or economy in relation to the number of specific inputs. It is also a measure of the efficiency of technology, management and the quality of inputs during some manufacturing processes (Syverson, 2011; Van Beveren, 2012). Since the 1990s, theoretical and empirical studies of TFP have developed rapidly as a result of support from information technology and new TFP methodologies. Nowadays, the increasing amounts of survey data from companies so that many aspects at the firm level can be analysed using TFP. Recommendations from TFP analysis for any economic sector, especially at the enterprise level, may help researchers and policymakers gain a better view of the sector.

With a coastline of more than 3200 km, the maritime sector, including seaports, warehousing and logistics, has become one of Vietnam's most promising economic sectors. With geographical advantages, Vietnam is on the international shipping route for the transfer of goods between Asia and other continents. The Northern seaports are the gateway connecting Hong Kong with mainland China, since all goods imported into China must go through Hong Kong. The southern seaports are used to deliver Asian goods to other nations worldwide. Transportation and logistics are thus an essential part of Vietnam's economic development with regard to investment and export. Vietnam's transportation volume by sea is quite large and has a long tradition of sustainable growth. This industry is highly centralized because all activities are concentrated in two major seaports, one in the South and another in the North, with some satellite seaports nearby.

Despite its importance, the development of the maritime sector in 28 coastal provinces is still limited with regard to infrastructure and policies. Many areas and cities have potential

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but the infrastructure conditions for transportation are not yet adequate. With regard to inter-city transport, traffic jams reduce economic efficiency and attractiveness for both local and international enterprises. It takes almost 2 hours to travel from the central district of Ho Chi Minh City to the new nearby cities during rush hours, despite the relatively short distances involved. Weak connections between regions and provinces may cause economic gaps, and Vietnam's regions work like independent oases rather than an integrated market.

To understand the productivity and competitiveness of the maritime sector in Vietnam, this study explores the factors affecting total factor productivity (TFP) of the seaports, warehousing and transportation in nearly 30 coastal provinces of Vietnam to provide recommendations for the sustainable industrial development of this sector. This research combines theoretical and empirical approaches to achieve this aim. To test the hypothesis, the first section of this paper is a literature review of current research on TFP and related areas. The second and third sections present data and methodology. The final part is about results and discussion.

## 2. Literature review.

### *2.1. General factors and the marine economic sector.*

The marine economic sector is an essential part of the economy of any country with a coastline. While contributing significantly to a country's GDP, this sector is also influenced by factors such as global macro trends in the environment, economy and society. However, these macro trends only indirectly impact shipping and seaports through a reduction in the growth of international exchange of goods (European Commission Horizon, 2018). In the context of globalization and information technology, individuals and companies, along with wider societies, have to change their business philosophies and orientation toward their core business, at the same time as outsourcing some other activities (Bistričić, Jugović and Kuzman, 2011). Shipping, especially sea shipping, is a major way of supplying raw materials, goods, foodstuffs and energy to people all around the world. At the same time, the world economy has a crucial influence on shipping demand. Any change in the world economy can change the operation of the sea shipping market (Jugović, Komadina and Hadžić, 2015).

State support also significantly impacts the marine economic sector by guiding and promoting seaport development and providing development budgets for seaports (Li, Lee and Hong, 2021). Similarly, Industry 4.0, advances in sciences, technology and information technology affect the total factor productivity of the marine economic sector, largely by influencing the mode of operation of ports based on digitizing their internal operating procedures. In addition, 3D printing technology also affects global logistics for transporting raw materials, semi-finished goods and finished products (Sulaiman et al., 2017).

The environment and climate change also affect the marine economic sector (Esmer, 2018). Climate change is altering the structure and productivity of fishing in all parts of the world. It also affects ocean tourism, especially tourism related to coral reefs (Gaines et al., 2020). In recent years, influenced by the eco-economy and green growth, the marine economic sector has begun to enter a stage of adjustment relating to environmental protection, preventing pollution by shifting from labour-intensive to technology-intensive and environmentally friendly approaches (Wei et al., 2021).

Employees with high levels of expertise in the marine economic sector often have higher productivity and are more creative. Human resources also improve the sector's efficiency and promote the scientific and rational development of the maritime economy (Wu, 2018). In many areas, such as Southeast Asia, labour resources for the marine economic sector are plentiful. However, there are still problems due to the shortage of R&D activities and high-level professionals in the field of renewable energy (CCICED, 2020).

From 2020 to the present, the marine economic sector in many countries worldwide has also been affected by the Covid-19 pandemic (Kedong et al., 2022). In efforts to prevent the expansion of the pandemic, many countries have closed their borders and suspended trade with others. This hugely impacted the tourism industry because many coastal areas were closed down (CCICED, 2020). Covid-19 also resulted in hundreds of thousands of seafarers being trapped on ships as routine crew changes could not be carried out, while similar numbers were stranded on land, prevented from re-joining ships (UNCTAD, 2021). The pandemic has caused massive damage to the world's marine economic sector.

### *2.2. Infrastructure, cost and maritime economic sector. Seaports' infrastructure.*

The infrastructure of a seaport refers to warehouses, container yards, ports, cranes, lifts and other equipment for marine transportation. This infrastructure reflects the cargo handling capacity of the seaports, which also affects the maritime economic sector (Matuga et al., 2019). Inadequate facilities cause cargo congestion at ports, and increase costs for stakeholders such as carriers, ports of import and export, road and rail transport companies and shippers (Henesey, Davidsson and Persson, 2009). Container yards are used to store shipping containers temporarily. If there is enough room, each container will be held in a different cell, allowing them to be transported faster and more easily. Cargo ports reflect the number and the speed at which containers are loaded in and out. In some ports, cargo gates use a Vehicle Booking System (VBS) to allocate container flows evenly daily and thus use the port's capacity more efficiently (Islam and Olsen, 2011).

Internal waterways with a short ocean shipping model have provided an effective alternative method to moving containers from one port to another, thus increasing the existing capacity of seaports. However, paying attention to the depth of these waterways is essential to accommodate the many types of ships docked. For example, a certain depth of water is required to receive large ships, and the size and design of berths differ according to the main purpose of individual ports (Maloni & Jackson, 2007).

### 2.3. Sea freight cost.

Transport cost is an essential factor in evaluating overseas shipping capacity. The development of maritime trade depends heavily on the efficiency of transporting goods by sea. Raw materials are only shipped from their original sources if the cost of marine activities is reduced to a reasonable level or can reach a baseline margin for product quality (Jugović, Komadina and Hadžić, 2015). However, transport costs are also affected by other factors such as the quality of warehouses and ports, the shipping industry or labour force, and the distance between transport points. With regard to infrastructure at ports, limited capacity of ports and warehouses will increase costs for users because it generates additional costs such as parking charges, and living expenses for drivers and shippers if they are obliged to wait for cargo (Dekker, 2005).

The shipbuilding industry also has an impact on sea freight charges. Shipping prices may decrease due to transportation overcapacity when ship breaking of old vessels is limited, but ship owners still receive new vessels (Girard and Kalaydjian, 2014). The shipping industry may also face additional costs from damage or attack (OECD, 2003). These are risks that marine economics and freight shipping services have to face.

Other factors that affect shipping capacity include the availability of a labour force, distance, funds to expand port capacity, and security for ports and shipping (Maloni & Jackson, 2007). In addition, freight rates at sea also affect the productivity of the fleet (speed of ships, time spent in port, time at sea and deadweight utilization), as do qualification of ships, the efficiency of shipbreaking, and operational losses.

## 3. Methods.

This study uses the production function to calculate the TFP of maritime economic enterprises in 28 coastal provinces of Vietnam. The empirical model is in line with one research from (Duc et al., 2022). Basically, the analyzed function is a Cobb-Douglas function as follows:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\phi} \quad (1)$$

in which:

$Y_{it}$ is the output of enterprise i in year t

$K_{it}^{\alpha}$ is the input of enterprise i in year t

$L_{it}^{\beta}$ is the (input) labour of enterprise i in year t

$M_{it}^{\phi}$ is the intermediate input of enterprise i in year t

$A_{it}$ is the TFP of enterprise i at year t

In this study, the maritime economic sector includes coastal passenger transport, ocean passenger transport, coastal freight transport, ocean freight transport, warehousing service, cold storage, warehousing of other goods, seaport operating activities and inland port operating activities. The productivity measure resulting from equation (2) can be used to directly analyze the influence and impact of various policy variables on enterprises, and the enterprise-level TFP can be aggregated for the industry level. The weight used to aggregate the whole TFP industry from firms is the proportion of output contribution at the firm level or the value-added (VA) ratio of each firm.

The industry's weighted average TFP reflects the maritime industry's technological efficiency and considers the importance of firm size in terms of labour and other firm characteristics. In addition, the results are used to analyze the impact of macro factors on the productivity of the maritime industry.

The TFP based on the weighted average composite for the maritime sector in 28 coastal provinces at time t is calculated as follows:

$$TFP_t = \sum_i \alpha_{it} \, x \, TFP_{it} \quad (2)$$

in which:

- TFPt is the TFP of the maritime sector at year t

- $\alpha$it = $VA_{it}/VA_t$ is the proportion of VA of enterprise i in year t within the VA of the whole maritime industry in year t

- TFPit is the TFP of enterprise i in year t.

Many factors can affect TFP, so equation (3) is

$$TFP_t = \alpha_0 + \alpha_1 X + \alpha_2 Z + \varepsilon_t \quad (3)$$

- $TFP_t$: Total productivity of the maritime industry in 28 coastal provinces

- X: Factors from the economy, including:

- Length from province i to the regional center. It can be hypothesized that provinces with convenient transportation to the regional center may attract large enterprises and obtain a higher TFP.

- $PCI_t$ of each province, including all components of PCI: this is a proxy variable measuring the impact of the business environment

- Z: Factors related to the characteristics of enterprises in the maritime industry, including:

- Firm size (by number of employees)

- Other factors

Many factors in provinces, including the cultural environment, natural advantages, and geographical location, may influence enterprises' location choices for the manufacture of both foreign direct investment (FDI) and domestically produced goods. Therefore, it is essential to remove these provincial effects. Equation 5 shows the first difference used to remove these effects. The first difference may be chosen because it is possible to reduce the serial correlation.

$$\Delta TFP_t = \alpha_0 + \alpha_1 \Delta X + \alpha_2 Z + \varepsilon_t \quad (4)$$

PCI is likely an endogenous variable of TFP. Firstly, PCI is an index reflecting the opinions of randomly selected enterprises about the quality of their business environment in year t. TFP is calculated at the end of year t (data collected on December 31 annually). Secondly, according to the data from the annual PCI reports, the quality of the local business environment changes slowly and stably. Therefore, it can be assumed that PCI is not rapidly affected by TFP in the same year. In other words, PCI has settled down before TFP is recognized.

## 4. Data.

The dataset used for this study was the annual enterprise survey carried out by the General Statistics Office of Vietnam (GSO), combined with the provincial competitiveness index from the Vietnam Chamber of Commerce and Industry (VCCI). Financial variables for the maritime economic sector were adjusted for the base year of 2010. The labour variable (L) unit is the number of workers employed during the year. Figures for capital (K), intermediate value (M), value-added (VA), and revenue (R) are in millions of VND.

The GSO of Vietnam has conducted an enterprise survey annually since 2001. Information is collected from enterprises operating in manufacturing and trading sectors across the country. This is a large-scale survey covering most enterprises operating in the economy (representatives of enterprises randomly sampled if less than 20 employees). The survey data covers business characteristics such as ownership type, including state enterprises, private enterprises, limited companies or joint stock companies and foreign-invested enterprises. In this study, to consider and evaluate the factors affecting the TFP of the maritime sector in 28 coastal provinces of Vietnam, the panel data of the enterprises is based on the GSO's Enterprise Survey results from 2012-2018.

The PCI data from 28 provinces along the coastal line of Vietnam is treated as an explanatory variable in the model, including the PCI and its components. In comparison, Provinces' GDP and length from a province to the regional center are also independent variables used to assess the TFP of the maritime sector. During the period 2012-2018, there were 4,709 enterprises in the maritime sector within the 28 coastal provinces in Vietnam (see Table 1). Most of the enterprises in the sample were micro and small enterprises (72%), and the majority were private enterprises, with only 179 FDI enterprises and 397 foreign enterprises. The PCI is considered the voice of the business community in evaluating local government, and is a combination of ten components to assess the business environment at the provincial level, including 1) Market entrance cost, 2) Accessibility to land for business, 3) Accessibility to information, and 4) Time cost. This paper selected some components in this index for inclusion in the empirical models.

Table 1: Types of Enterprises within the Maritime Economic Sector.

| | Private | State | FDI | Total |
|---|---|---|---|---|
| Rather small | 1,402 | 1 | 32 | 1,435 |
| Small | 2,075 | 93 | 34 | 2,202 |
| Medium | 352 | 49 | 33 | 434 |
| Large | 304 | 254 | 80 | 638 |
| **Total** | **4,133** | **397** | **179** | **4,709** |

Source: Calculated from GOS's dataset.

The provincial gross domestic product index (RGDP) is calculated from the GRDP of the coastal provinces based on the price in the year 2010.

$$GRDP\_SS_{jt} = \frac{GRDP\_HH_{jt}}{DGDP_t}$$

In which:

$GRDP\_SS_{jt}$: GRDP based on the price in 2010 in province j, year t

$GRDP\_HH_{jt}$: GRDP based on the current price in province j, year t

$DGDP_t$: DGDP of the whole nation at year t, calculated by:

$$DGDP_t = \frac{GDP\_HH_t}{GDP\_SS_t}$$

$GDP\_HH_t$: GDP based on the current price, year t

$GRDP\_HH_{jt}$: GDP based on the price in 2010, year t.

The center of the region contains provinces and cities, which are the places with the highest GRDP. They are the centers of international trade and transactions, have large consumption markets and provide convenient connections from place to place. The greater the distance between an area and the region's centre, the greater is the cost to enterprises of transporting products to consumers. This means weaker economic links and less favourable conditions for any industrial development. Consequently, the centers of the sub-regions in this study are defined as follows:

The index of length to the center of the province is calculated according to the following formula:

$$Aver\_leng_r = \frac{\sum Length_{jr}}{n_r}$$

in which,

- $\sum Length_{jr}$: The length from the center of a province to the area.
- $n_r$: Number of provinces within the region

## 5. Results and Discussion.

Table 2 reports the results of estimated models of model 1 for the maritime economic sector of 28 coastal provinces of Vietnam and the TFP of enterprises in the same industry. The length from each province to the regional center is fixed. Therefore, the random effect model (REM) is used to measure in models 1 & 2. A robust method is applied for both models to remove autocorrelation and multicollinearity.

Firstly, the estimated results of both models show that the local GDP growth rate positively impacts the productivity of enterprises in the maritime sector and the productivity of the whole industry. This means that the more the local economic situation develops, the higher the labour productivity of the maritime industry in 28 coastal provinces will be. The coefficients of the components within the PCI show the impact of state management on the productivity of the maritime industry in the coastal provinces of Vietnam over the past few years.

This finding is relevant to findings in China, with a sample of 390 manufacturing firms (Karplus, Geissmann and Zhang, 2021). The variation in ownership differentiates the relative influence of state and market institutional logic on firms in China's transition economy. The authors show that, on average, a firm's

Table 2: Panel Data Analysis for TFP in the Maritime Industry.

| Variables | TFP of the maritime industry | TFP of enterprises in the maritime industry |
|---|---|---|
| Provincial GDP | 0.013*** | 0.167*** |
| | (0.001) | (0.033) |
| Market entry cost | -0.002* | -0.039 |
| | (0.001) | (0.033) |
| Assessibility to land | 0.004*** | -0.038 |
| | (0.001) | (0.032) |
| Assessibility to information | 0.016*** | 0.092** |
| | (0.001) | (0.041) |
| Time cost | 0.008*** | -0.005 |
| | (0.001) | (0.027) |
| Informal cost | -0.001 | -0.006 |
| | (0.001) | (0.027) |
| Level of equal competitiveness | -0.000 | 0.006 |
| | (0.000) | (0.011) |
| Proactivity of local leadership | 0.002** | 0.005 |
| | (0.001) | (0.024) |
| Business support services | -0.002*** | -0.057* |
| | (0.001) | (0.031) |
| Labour and training | 0.013*** | 0.175*** |
| | (0.001) | (0.031) |
| Legal institutions | -0.002*** | 0.008 |
| | (0.001) | (0.019) |
| Sectoral competitiveness | 0.028*** | 0.105 |
| | (0.006) | (0.139) |
| Firm size | -0.002*** | 0.167*** |
| | (0.001) | (0.031) |
| Import | 0.000 | 0.165*** |
| | (0.002) | (0.061) |
| Export | 0.008*** | 0.151** |
| | (0.002) | (0.068) |
| Length | 0.002* | -0.011 |
| | (0.001) | (0.023) |
| Constant | 0.093*** | 0.985* |
| | (0.017) | (0.557) |
| Observation | 2,494 | 2,494 |

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

overall management practice score is positively and significantly related to the TFP in state-owned firms. However, the correlation is not significantly different from zero in both domestic and foreign private firms. These findings support a role for structured management practices as a response to institutional complexity by enabling firms to satisfy multiple imperatives from distinct audiences.

A positive relationship between management and productivity was also recognized across six industries in research in Japan (Kambayashi, Ohyama and Hori, 2021). The authors also used management scores constructed from survey questions about management practices that measured the quality of operational efficiency embedded in a set of management practices. The authors concluded that the patterns of management practices and their association with potential drivers were quite similar across the six industries The management scores were positively associated with labor productivity in most industries.

The variables of market entrance cost, informal cost and level of equal competitiveness did not have a statistically significant effect on the productivity of the maritime economy in the coastal provinces. In contrast, the explanatory variables of accessibility to land, accessibility to information, time cost, proactivity of provincial leadership, and labour and training significantly impacted industrial productivity. Accordingly, when these factors are improved and increased, the productivity of the maritime industry also increases. This result is quite similar to the findings of previous studies on the impact of state management on productivity. Consequently, if the official costs are reduced by better state management of enterprises, the TFP of the maritime industry in the provinces will increase. For an enterprise's TFP, the estimated coefficients of these indicators also have a statistically significant impact on the productivity of the enterprises.

However, the estimated coefficients of these indicators are small, showing that the impact of macroeconomic management on the maritime industry's productivity has not been as high as expected. The improvement of the macro environment has not yet created a significant change in the productivity of the industry or for enterprises within the industry. The coefficient of the business support services also had a negative impact on the labor productivity of the industry, although it was still small.

Competitiveness plays a vital role for all kinds of firms. From the empirical models, the results indicate that the industry's competitiveness positively impacts the productivity of the maritime economy in the coastal provinces. In summary, as the industry's level of competition increases, the industry's productivity is higher. This result is consistent with previous research conducted in China by Kong et al. (2022), who used the enactment of China's antitrust policy as a quasi-natural experiment. The authors found that the TFP of firms with larger market power showed a significant increase after the enactment of the Chinese Anti-Monopoly Law. Possible explanations for these effects are that the rising competition pressures, caused by the antitrust policy, induced firms to increase their investment efficiency and innovation output. Similarly, Le et al. (2019) also confirmed in the case of Vietnam that market competition has been effective in enhancing average firm productivity and in reducing the gaps in efficiency across ownership types. SOEs' remarkable performance may be linked to several concurrent factors experienced during the period 2001–2011, including the restructuring of the state sector during the 2000s, and the increased economic integration due to the country's accession to the World Trade Organization in 2007.

The labour force, in terms of employee volume, is firms' human capital. Firms with skilled workforces will likely have higher productivity compared to firms with less skilled workers. As expected, model 1 and model 2's estimation results support the conclusion that firm size positively impacts the total productivity of enterprises in the maritime industry. The larger enterprises are, the higher their productivity. This effect both positive in the model 1 and 2 means that import and export activities have the same direction with the productivity of enterprises in the maritime sector. In the past few years, the implementation of international trade has positively impacted the total productivity of the maritime industry in Vietnam. This is in line with an article by Mahadevan and Suardi (2011), in which the authors investigate the trade-productivity growth relationship by incorporating uncertainty/volatility in a VECM-GARCH model. Using Singapore as a case study, the study provided evidence supporting the crucial role of imports as a beneficial conduit for growth in the TFP and labour productivity, even after controlling for economic uncertainty in the model.

The final independent variable displayed in the model is the length between regions. The coefficient of length from each province to the regional center does not have a statistically significant impact on the productivity of firms in the industry. However, this variable positively impacts the industry in model 1 and this significant coefficient supports the hypothesis that for enterprises, the nearer they are to a regional center, the higher their productivity will be.

## Conclusions.

At the macro level, the better the management environment is, the higher is the TFP of enterprises. However, the macro environment's positive impact on the TFP of the maritime industry is not as high as expected, as shown by the small coefficients in the models. Thus, to strengthen the maritime industry's productivity and create favourable conditions for its activities, the local authorities in the coastal provinces of Vietnam should take practical action to create a flexible business environment. To improve the macro indicators, reduction in administrative procedures and improvement of public services should be carried out synchronously. At the same time, it is necessary to have appropriate policies to help businesses to access resources such as land and information.

At the micro-level, firm size is directly proportional to the TFP of Vietnam's maritime sector. The larger enterprises are, the higher is their productivity. Maritime economic activities include many sectors, such as seaports and warehousing. This industry can apply modern technology to improve productivity, management, infrastructure and services. The development of the maritime sector may require intensive training and use of human resources for the whole economy and the government. Correspondingly, if the maritime sector develops faster, individuals will benefit from this process.

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