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Determinants of blue economy in Asia-Pacific island countries: A study of tourism and fisheries sectors

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ABSTRACT

This study examines the determinants of blue economy activities, namely tourism and fisheries, in 19 Asia-Pacific Island countries for the period 1996 to 2016. Using a panel data model, we find that the size of the blue economy positively depends on gross fixed capital formation and access to electricity. We also find that the size of the blue economy responds positively to sustainable ocean management policies. Hence, our findings support the need for, and the effectiveness of, sustainable ocean governance policies in the Asia-Pacific Island countries to further strengthen the growth of these countries.

1. Introduction

The importance of promoting the 'blue economy' has been recognized since the Rio+20 conference of 2012, brought about mainly by coastal countries. As defined by the World Bank, the blue economy implies 'sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem' (World Bank, 2017). The components of the blue economy, as identified by the World Bank (2017), include fisheries, tourism, maritime transport, aquaculture, off-shore renewable energy, seabed extractive activities, marine biotechnology and bioprospecting.

The concept of the blue economy is also recognized by the United Nations Sustainable Development Goals in SDG 14, which sets a target that by 2030 economic benefits will increase for small island developing states (SIDS) and least developed countries (LDCs) from sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism (Spalding, 2016). Numerous studies (Attri, 2016; Keen et al., 2018; Smith-Godfrey, 2016; World Bank, 2017) identify a working definition and framework to understand the blue economy. Smith-Godfrey (2016) identify five activities, extraction of living resources, extraction of non-living resources, new resource generation, trade in resources including tourism and recreation and ocean health as the components of the blue economy. A similar classification is extended in a World Bank report on understanding the potential of the blue economy (World Bank, 2017). While Keen et al. (2018) consider ecosystem resilience, economic sustainability, community engagement, institutional integration, and technical capacity as important dimensions to conceptualize the blue economy, other studies, for example Attri (2016) and Techera (2018), recognize the importance of good governance, legal resource management, monitoring and regulatory reforms as the main pillars supporting national blue economies. Ehlers (2016) and Barbesgaard (2018) identify several strategies to enhance ocean governance mechanisms to improve growth in the blue economy, including establishment of a financing system for conservation and sustainable use of the seas. Apart from conceptualization of the blue economy, several attempts have already been made to measure the size of the blue economy. But the scope of such studies is limited and confined mainly to developed countries and a few Asian countries (e.g. Carvalho et al., 2018; Mohanty et al., 2014; Mohanty, 2018). Blue economy activities are also identified as a major employment generator (Pauli, 2010; Pranathi and Gonchkar, 2019). Hence, several studies support expansion of blue economy activities but simultaneously

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emphasize the importance of maintaining sustainability (Golden et al., 2017; Kathijotes, 2013; McKinley et al., 2019; Moolna and Thompson, 2018; Spalding, 2016). Most studies on the blue economy address its conceptualization, emphasising the need for valuation of ocean ecosystem services and the role of ocean governance. However, no study has conducted an empirical investigation of the drivers of the blue economy, especially in the context of island countries; the present study addresses this gap. This study contributes to the existing literature by empirically examining determinants of blue economy activities, namely fisheries and tourism, in the context of Asia-Pacific Island countries over two decades from 1996 to 2016. This empirical investigation will help policy makers identify the major driving forces behind the growth of blue economy activities, namely tourism and fisheries, in the Asia-Pacific Island countries. This will help focus policy interventions.

We focus on the growth of Asia-Pacific Island countries with reference to two blue economy sectors, fisheries and tourism. We also examine whether and how factors like investment, environmental quality, trade openness and ocean management policies influence the size of the blue economy with particular reference to fisheries and tourism. Asia-Pacific Island countries today occupy a central place in the world economy. The share of the Asia–Pacific region in total world Gross Domestic Product (World GDP) increased from 28.4% in 1995 to 33.3% in 2016 (World Bank, World Development Indicators, 2018). According to the Asian Economic Integration Report, the region's growth in trade increased by 1.7% in 2016 from 1.4% in 2015, while world trade decelerated (Asian Development Bank, 2017). Despite an impressive regional growth performance, many Asia-Pacific Island countries have been declared LDCs, and real GDP growth rates in these island countries are lower than in other countries in this region (International Monetary Fund, 2018). A recent World Economic Forum report reveals that for most of Asia-Pacific Island countries, ocean area as a percentage of total territorial area is more than 80% (Degnarian and Stone, 2017), signifying the importance of the blue economy in these countries.

To identify the driving factors behind the blue economy, we use a panel data model and our analysis encompasses three sets of estimates. The first set considers the overall size of the blue economy, while the second and third sets take into account the production of the fisheries and tourism sectors separately. To check the robustness of our results, we use alternative model specifications for the aforementioned sets of estimates and find results consistent with the benchmark models. Our analysis reveals that gross fixed capital formation, availability of electricity, a higher degree of trade openness and exports influence blue economy activities favourably. Moreover, the results indicate that sustainable ocean management policies catalyse blue economic activities.

This paper proceeds as follows. Section 2 describes the framework for selecting relevant variables for empirical analysis. Section 3 discusses the data and methodology. Section 4 presents the empirical results. Finally, Section 5 sets forth conclusions and policy recommendations.

2. Framework for selection of variables and measurement

This study considers 19 island countries located in the Asia-Pacific region listed by the World Population Review (World Population Review, 2020). Island countries are defined as countries comprising one or more islands, or land that is surrounded completely by water. This study includes Indonesia, the Philippines, Sri Lanka, Papua New Guinea, New Zealand, Timor-Leste, Solomon Islands, Fiji, Brunei Darussalam, Maldives, Vanuatu, Samoa, Tonga, the Federated States of Micronesia, Kiribati, the Marshall Islands, Palau, Nauru, and Tuvalu. We chose the time period 1996–2016 based on availability of data on an annual basis for all variables used. The analysis is divided into three sets of estimates. First, we examine the factors determining the size of the blue economy.

2.1. Factors determining size of the blue economy

The World Bank and the United Nations have identified various sectors, including traditional sectors like fisheries, tourism and maritime transport, along with emerging activities such as offshore renewable energy, aquaculture, seabed extractive activities and marine biotechnology and bioprospecting as blue economy sectors. But time series data on all the aforementioned indicators for the countries under consideration are not available. The available resources to gauge the size of the blue economy comprise only scattered reports for these countries. The International Union for Conservation of Nature (IUCN) report by Seidel and Lal (2010) provides data on the share of marine offshore capture fisheries, coastal tourism, mariculture, and collection of fees for providing ocean rights in total GDP for 2008 for Vanuatu, Samoa, Tonga, the Federated States of Micronesia, Kiribati, Palau, Nauru, Tuvalu, Solomon Islands, Fiji and Papua New Guinea. Some countries, like Fiji and the Marshall Islands, also have a minimal amount of coastal mining, but the available information is limited.

Hence, we extract the blue economy share of the total economy for the aforementioned countries from this report. For the remaining countries of our sample, we source the share of the blue economy from other official sources and record the figures (for details see Appendix 1). In the next step, we estimate the size of the blue economy for these countries by multiplying their real GDP by their respective blue economy share. This blue economy size is taken as the dependent variable in the first estimation set.

Investment captured by gross fixed capital formation (GFCF) is one of the major determinants of economic output as per standard macroeconomic theory. Theoretically, it is expected that the higher the GFCF, the higher the output will be. Several empirical studies emphasize the effect of GFCF on agricultural output (Fan et al., 2002; Gulati and Bathla, 2001; Marimuthu, 2013), on tourism (Eugenio-Martin et al., 2008; Zaman et al., 2016) and on overall GDP (Ding and Knight, 2011). Hence, we take the share of GFCF as a percentage of GDP as an explanatory factor favourably influencing the size of blue economy output. The linkage between electricity use, considered a proxy for infrastructure availability, and economic performance of a country has been examined (Best and Burke, 2018). Many blue economic activities like post-harvest activities in fisheries and shipbuilding are heavily dependent on access to electricity. Hence, we take electricity as an explanatory variable and as a determinant of blue economic activity. The role of information and communication technology (ICT) in economic growth has been studied by various authors (Avgerou, 2003; Schreyer, 2000; Vu, 2011). The favourable role of ICT has also been examined in the context of fisheries and tourism, two major sectors in the blue economy (Joshi and Ayyangar, 2010; Omar et al., 2011). Since ICT is considered a productivity enabler, we expect the ICT variable, captured by mobile cellular subscriptions per 100 people, will be positively related to the size of the blue economy.

Since the blue economy concept is related to sustainability, we examine whether and how environmental quality influences blue economic activities; thus, we include carbon dioxide (CO_2) emissions per person as an independent variable. Increased concentrations of CO_2 in the atmosphere have led to CO_2 absorption in the oceans, altering (acidifying) the chemistry of the top layers, which may harm a wide range of marine organisms, eventually degrading entire marine ecosystems (McMullen and Jabbour, 2009). Global surface ocean pH has decreased over the last 100 years due to increased atmospheric CO_2 (World Tourism Organization, 2012). As is evident from the literature, we expect that CO_2 emissions will have a negative effect on both tourism and, indirectly, fisheries production via ocean uptake of human-produced CO_2 (Cheung and Law, 2001; Dong et al., 2019; Sullivan and Lindsey, 2018).

Trade openness, calculated as exports plus imports as a percentage of GDP, is another explanatory variable we consider. The theoretical literature propounds that trade openness can contribute to economic growth through access to goods and services, efficient allocation of resources, and improvement in total factor productivity through technology diffusion (Grossman and Helpman, 1991; Romer, 1990).

However, the effect of trade openness may also dent economic growth by increasing inflation and lowering exchange rates (Cooke, 2010; Samimi et al., 2012). Various empirical studies find mixed evidence for the effect of trade openness on economic growth (Dar and Amirkhalkhali, 2003; Musila and Yiheyis, 2015; Yanikkaya, 2003).

Similarly, in the empirical and theoretical literature on blue economic activity, the evidence on the impact of trade openness is not conclusive. Theoretically, this linkage could stem from three principles: (i) via a network effect where trade boosts business travel (Chaisumpunsakul and Pholphirul, 2018; White, 2007); (ii) via product advertisements required for trade, which create awareness about the product and its country of origin (Kulendran and Wilson, 2000); and (iii) by providing better infrastructure. While findings in some empirical studies are in tandem with the literature showing a positive association between trade and tourism demand (Chaisumpunsakul and Pholphirul, 2018; Habibi and Ahmadzadeh, 2015), some studies support a negative relationship between these two factors in the short-run (Shahbaz et al., 2017). Though trade openness according to the theory of export-led growth may have a positive impact on overall economic growth, its impact on fisheries production might be negative, since trade liberalization may lead to overfishing, hence negatively impacting fish production (Abe et al., 2017; Erhardt, 2018). It is also argued that this relation depends on the quality of fisheries management and ocean governance.

The size of the blue economy also depends on international fisheries governance initiatives. In 2002, the Pacific Island Regional Ocean Policy (Secretariat of the Pacific Community, 2005) was endorsed by the leaders of Pacific Island countries with a vision toward greater understanding of the oceans, sustainable use of ocean resources, managing the health of the ocean, and creating greater cooperation. To understand whether such policies have facilitated blue economy activities, we take a dummy for Pacific Island countries that assumes 1 for Pacific Island countries from 2003 onwards and 0 for the period 1996–2002. Similarly, in 2003, the Sustainable Development Strategy for the Seas of East Asia was adopted and various coastal zone management programs were implemented in Asian countries. Thus, the policy dummy for Asian countries assumes a value of 1 from 2004 onwards and 0 for the period 1996–2003. Moreover, we examine the impact of the Global Financial Crisis (GFC) and general slowdown of world economic activity on the blue economy of Asia-Pacific Island countries by introducing a dummy that assumes a value equal to 1 from the year 2007 onwards and 0 for 1996–2006. Next, we separately examine the macroeconomic factors affecting major blue economic activities, namely tourist arrivals and fisheries production.

2.2. *Factors affecting fisheries production*

The second set of estimates considers fisheries production (in metric tonnes) as a dependent variable. Fisheries production is expected to be positively affected by the price of fish, following the law of supply often with a lagged effect, reflecting the possibility that better export opportunities may induce fisheries to produce more output. The overall access to and availability of electricity (a proxy for infrastructure) and GFCF are expected to have a positive effect on fish production.

Since here our concern is to assess the determinants of fish production specifically, we consider GFCF by country in agriculture, forests and fisheries to represent the availability of physical capital in fisheries production instead of GFCF for the country as a whole. A better indicator of capital in the context of fisheries production would consider the number of fishing vessels. But due to a lack of availability of consistent time series data for the countries under consideration, we had to use the GFCF in agriculture, forests and fisheries as a proxy for investment; this is a limitation of this study.

Though a body of literature exists on higher fisheries production coming at the cost of higher emissions of greenhouse gases (Parker et al., 2018; Tyedmers et al., 2005; Vivekanandan et al., 2013), some recent literature points out that emission of CO_2 leads to ocean acidification and hence may dent fisheries production (Cooley and Doney, 2009; Narita et al., 2012). Thus, as discussed earlier, we expect that a higher CO_2 emission level may affect fisheries production negatively. As in many economic activities, fisheries production is expected to be favourably influenced by the facilities provided by ICT. Mobile phone use facilitates access to marketing, price and weather information for fishermen and is thus expected to boost fisheries production, as described in Ifejika et al. (2009) and Evoh (2009). The dummy variable for sustainable ocean management policy is expected to yield a positive impact on fish production, due to its components that are conducive to sustainable use of fisheries resources and intergovernmental cooperation. The dummy for crisis is expected to reflect declining demand and hence a negative impact on blue economic activity, namely fisheries.

2.3. *Factors determining inbound tourist arrivals*

The third set of estimates in our analysis is to examine the factors affecting inbound tourist arrivals. Inbound tourism constitutes the activities of a visitor travelling to a place outside the visitor's usual environment for not more than 1 continuous year and not less than 24 hours. Such travel is for activities other than those remunerated from within the country visited. In the data for inbound tourist arrivals, a person who makes several trips to a country during a given period is counted each time as a new arrival. Devaluation/depreciation of a country's currency makes international tourism less expensive and attracts travel flows to that country. Hence, the coefficient of the exchange rate is expected to be positive. We choose nominal exchange rate, defined as the number of units of local currency per US dollar for our analysis.

The nominal exchange rate better captures the volatility-driven uncertainty faced by would-be tourists as compared to the effective exchange rate, which does not provide much information about the direction of a country's currency. If a country's currency depreciates against one country and appreciates against another, the direction of tourist arrivals due to exchange rate changes remains undetermined. The nominal exchange rate as a determinant is clear, since depreciation of a given currency relative to others can increase the demand for tourism, as domestic prices become relatively cheaper. Prices at the destination relative to prices at home are an important determinant of tourism choices.

We believe sustainability and competitiveness go hand in hand, as destinations and businesses become more competitive through efficient use of resources and the efficiencies of the internet. Theoretically, we expect the coefficient of relative price to be negative, since better connectivity and falls in the relative price of the home country relative to a foreign country make domestic goods more competitive compared to foreign goods, resulting in increased inflow of foreign tourist arrivals. Relative price is calculated as each country's consumer price index (CPI) with respect to world CPI (e.g. Indonesia's CPI/world CPI). The role of ICT in promoting tourism is expected to be favourable, since better ICT facilitates better information and connectivity attracts more tourists (Hughes and Moscardo, 2019; Kim and Kim, 2017). Income level in the country of origin affects positively the ability and inclination of people to travel abroad. As tourist arrivals depend on source country income, we expect a positive sign for the coefficient of world income/foreign income and hence we include world GDP (world income) as a determinant of tourist arrivals. The tourism of a country may also be influenced by the environmental quality of that country. There is a consensus that tourists will not travel to polluted destinations if there are alternative destinations available at comparable prices. Climate change, along with other sources of environmental degradation, can have an adverse impact on the sustainability of the tourism industry in small island developing countries. The literature shows that tourist arrivals are active contributors to pollution and that higher pollution hinders tourist arrivals. Hence, the relation between tourist arrivals and environmental quality could be positive or negative. (A tabular representation of the variables included in various sets of estimations and their expected signs is provided in Table 1.)

3. Data and methodology

We investigate determinants of the size of the blue economy and blue economy activities in the Asia-Pacific island countries region using panel data analysis. We use a panel data model since panel data blend inter-country differences and intra-country dynamics and have several advantages over cross-sectional regression. Panel data provide more degrees of freedom and more sample variability than cross-sectional data and improve the efficiency of econometric estimates [for details refer to Hsiao (2007)].

Algebraically the panel data model can be written as:

$$lnY_{it} = \alpha + X_{it}\beta^{'} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where lnY_{it} takes three diffrent forms -the logarithm of size of the blue economy of country i in time period t (lnY_{1it}), total fisheries production of country i in time period t (lnY_{2it}) and the number of tourist arrivals in country i in time period t (lnY_{3it}); X_{it} is a set of explanatory variables that determine lnY_{it}. ; $\beta^{'}$ is the slope coefficient vector associated with the explanatory variables; α is the intercept term; μ_i is an unobserved country-specific effect; δ_t is the time trend; and ε_{it} is the error term that is independently and identically distributed among countries and years. Equation (1) is further expanded in three models as described below.

The first set of estimations considers lnY_{1it} as the dependent variable. The equation is specified as:

$$lnY_{1it} = \alpha + \beta_1 lnGFCF_{it-1} + \beta_2 lnELC_{it} + \beta_3 lnCO2_{it} + \beta_4 lnICT_{it} + \beta_5 lnTOT_{it} + \beta_6 CRISIS_{it} + \beta_7 POLICY_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

where *lnGFCF* is the natural logarithm of GFCF as a percentage of GDP; *lnELC* is access to electricity as a percentage of the population; *lnCO2*is the logarithm of per capita CO_2 in metric tons; *lnICT* is the mobile subscription rate measured as the number of mobile cellular subscriptions per 100 people; *lnTOT* is the logarithm of trade openness calculated as exports plus imports as a percentage of GDP; and *CRISIS* is a dummy variable that assumes a value of 0 for the period 1996–2006 and is equal to 1 from 2007 onwards. *POLICY* is a dummy variable taking the value 1 from 2003 onwards and 0 otherwise for Pacific Island countries, and is equal to 1 from 2004 for Asian island countries and 0 otherwise. The coefficients of *lnGFCF*, *lnICT*, *lnTOT*, *lnELC*, and *POLICY* are expected to have a positive impact on lnY_1 while *lnCO2* and *CRISIS* are expected to have a negative impact on lnY_1(see Section 2 for justification of including the explanatory variables).

In the second set of estimations, we identify the determinants of

Table 1
Variable descriptions and data sources.

Objectives	Independent Variables	Descriptions of Variables	Expected Sign	Data Sources
Factors determining size of Blue Economy Dependent variable: *Y1:* Share of blue economy in GDP (Data source: Compiled from various reports as explained in Appendix 1)	Gross Fixed Capital Formation (*GFCF*)	*GFCF*: gross fixed capital formation as a percentage of GDP	+ve	FAOSTAT
	Electricity Consumption (*ELC*)	*ELC*: access to electricity as a percentage of the population	+ve	WDI
	Carbon Dioxide Emissions (*CO_2*)	*CO_2*: per capita CO_2 in metric tons	-ve	WDI
	Information and Communication Technology (*ICT*)	*ICT*: mobile cellular subscriptions per 100 people	+ve	WDI
	Trade Openness (*TOT*)	*TOT*: trade openness calculated as exports plus imports as a percentage of GDP	+ve	WDI
	CRISIS	*CRISIS*: dummy variable equal to 0 for the period 1996–2006 and equal to 1 from 2007 onwards	-ve	–
	POLICY	*POLICY* : dummy variable equal to 1 from 2003 onwards and 0 otherwise for Pacific Island countries, and equal to 1 from 2004 for Asian island countries and 0 otherwise	+ve	–
Factors determining fisheries production Dependent variable: *Y2*: Fisheries production (in metric tonnes) (Data source: FAOSTAT)	Fish Price (*FPRICE*)	*FPRICE*: global fish price (in US$ per metric ton)	+ve	IMF
	EXPORT	*EXPORT*: fisheries exports in metric tonnes	+ve	FAOSTAT
	Gross Fixed Capital Formation in agriculture, forestry, and fishing (*GFCFA*)	*GFCFA*: gross fixed capital formation in agriculture forestry and fisheries	+ve	FAOSTAT
	Carbon Dioxide Emissions (*CO_2*)	*CO_2*: per capita CO_2 in metric tons	-ve	WDI
	Electricity Consumption (*ELC*)	*ELC*: access to electricity as a percentage of the population	+ve	WDI
	Information and Communication Technology (*ICT*)	*ICT*: mobile cellular subscriptions per 100 people	+ve	WDI
	CRISIS	*CRISIS*: same as defined earlier	-ve	–
	POLICY	*POLICY* : same as defined earlier	+ve	–
Factors determining tourist arrivals: Dependent variable: *Y3*: inbound tourist arrivals (Data source: WDI)	World Income (*WORLD_IN*)	*WORLD_IN*: world GDP (expressed as constant 2010 US$)	+ve	WDI
	Relative Price (*RP*)	*RP:* a country's CPI with respect to world CPI	-ve	WDI
	Exchange Rate (*EXG*)	*EXG*: number of units of local currency per US Dollar	+ve	WDI
	Carbon Dioxide Emissions (*CO2*)	*CO2*: per capita CO_2 in metric tons	-ve	WDI
	Trade Openness (*TOT*)	*TOT*: trade openness calculated as exports plus imports as a percentage of GDP	+ve	WDI
	Information and Communication Technology (*ICT*)	*ICT*: captured by mobile cellular subscriptions per 100 people	+ve	WDI
	POLICY	*POLICY* : same as defined earlier	+ve	–
	CRISIS	*CRISIS* : same as defined earlier	-ve	–

Notes: (a)FAOSTAT: Statistical database of Food and Agricultural Organization, FAOSTAT (2019), WDI: World Development Indicators, World Bank (2019), IMF: International Monetary Fund (2020) (b) The units of measurement are mentioned as reported in the data sources, Source: Compiled by authors.

fisheries production in the island countries under consideration; hence, lnY_2 is taken as a dependent variable. The equation is specified as follows:

$$lnY_{2it} = \alpha + \beta_1 lnFPRICE_{it-1} + \beta_2 lnEXPORT_{it-1} + \beta_3 lnCO2_{it} + \beta_4 lnELC_{it} + \beta_5 lnICT_{it} + \beta_6 lnGFCFA_{it-1} + \beta_7 POLICY_{it} + \beta_8 CRISIS_{it} + \mu_i + \delta_t + \varepsilon_{it} \tag{3}$$

where *lnFPRICE* is the logarithm of global fish price (in US$ per metric ton); *lnEXPORT* denotes the logarithm of fisheries exports in metric tonnes; *lnGFCFA* is the logarithm of GFCF in agriculture, forestry, and fishing; *lnCO2* is the logarithm of CO_2 in metric tons per capita; *lnELC* is access to electricity as a percentage of the population; *lnICT* is the mobile subscription rate measured as the number of mobile cellular subscriptions per 100 people; *CRISIS* is a dummy variable that assumes a value of 0 from 1996 to 2006 and is equal to 1 from 2007 onwards; and *POLICY* is a dummy variable assuming a value equal to 1 from 2003 onwards and 0 otherwise for Pacific Island countries, and is equal to 1 from 2004 for Asian island countries and 0 otherwise. The coefficients of *lnGFCFA*, *lnICT*, *lnFPRICE*, *lnEXPORT*, *lnELC*, and *POLICY* are expected to have a positive impact on lnY_2, while *lnCO2* and *CRISIS* are expected to have a negative impact on lnY_2 (see section 2 for justification of including the explanatory variables). Note that since in Equation (2) the dependent variable is the overall size of the blue economy, we take GFCF, other infrastructure and trade variables at the country level without considering sector specificities. But while estimating the determinants of one of the components of the blue economy, i.e. fisheries production, we include more sector-specific variables subject to data availability. Hence, in Equation (3) we include sector-specific variables like fish price (*FPRICE*) and fish exports (*EXPORT*), which have implications for fisheries production, as discussed in Section 2. Also, instead of considering total GFCF, we consider GFCF in agriculture, forests and fisheries as an indicator of investment in Equation (3).

In our third set of estimations, to understand the determinants of tourist arrivals in the Asia- Pacific Island countries, lnY_3 is taken as the dependent variable. In this estimation, we include the variables world income (*WORLD_IN*), trade openness (*TOT*), information and communication technology (*ICT*), exchange rate (*EXG*), carbon dioxide emissions (CO_2) and relative price (*RP*) of the country as independent variables, since these factors are expected to have specific influence on tourism activities, including tourist arrivals. The equation is specified as follows:

$$lnY_{3it} = \alpha + \beta_1 lnWORLD\_IN_{it} + \beta_2 lnRP_{it} + \beta_3 lnEXG_{it} + \beta_4 lnTOT_{it} + \beta_5 lnCO2_{it} + \beta_6 ICT_{it} + \beta_7 POLICY_{it} + \beta_8 CRISIS_{it} + \mu_i + \delta_t + \varepsilon_{it} \tag{4}$$

where *lnWORLD_IN* is the logarithm of world income; *lnRP* is the logarithm of relative price; *lnEXG* is the logarithm of nominal exchange rate; and *lnTOT* is the logarithm of trade openness calculated as exports plus imports as a percentage of GDP. All other explanatory variables used in Equation (4) are as in Equation (2). As explained in Section 2, we expect the coefficients of *lnWORLD_IN*, *lnTOT*, *lnICT*, *lnEXG*, and *POLICY* to be positive, whereas the coefficients of *lnRP*, *lnCO2*, and *CRISIS* are expected to be negative.

World CPI data are not directly available and hence are calculated as the average of the CPI of all countries. Instead of directly using domestic CPI as the covariates in the models, we use relative price, since it is more appropriate from the tourist's perspective, and it is with respect to the world price level, which is used as the proxy for 'world CPI'.

The list of variables used for each of the three sets of estimates and their respective data sources are shown in Table 1.

4. Empirical results

This section describes our empirical results. Let us begin with a description of Table 2, which presents the annual growth rate of blue economy activities over two periods: period I: 1996–2007 and period II: 2008–2016.

Observe from Table 2 that most of the Asia-Pacific Island countries exhibit a stronger growth rate in tourist arrivals in period II (2008–2016) (post-GFC) than in period I (1996–2007) (pre-GFC). The figures indicate that apart from larger countries like Indonesia and Sri Lanka, small island countries of the Pacific region like Kiribati, Tuvalu, and Vanuatu show a higher growth rate of tourist arrivals in period II than in period I. However, many countries faced deceleration in growth of fisheries production in period II as compared to period I. As is evident from Table 2, for countries like the Philippines, Fiji, Maldives, Samoa and Vanuatu, the positive growth rate of fisheries production in period I turned into a negative one in period II. However, countries like Indonesia, Sri Lanka, Timor-Leste, Solomon Islands, Brunei Darussalam, Federated States of Micronesia and Kiribati observed high growth in fisheries production during period II as compared to period I.

Next, we present key descriptive statistics, including mean, median, standard deviation, skewness, kurtosis and Jarque–Bera normality test of both dependent variables and explanatory variables in Table 3. The log mean size of the blue economy (lnY_1) for the sample of Asia-Pacific countries is 19.85 and the standard deviation is 2.37. Log mean size of the blue economy is negatively skewed. Similarly, the Jarque–Bera normality test statistic is 14.22, which implies that the series is not normally distributed. But typically, the Jarque–Bera test statistic does not follow a normal distribution pattern for a small sample size. Table 3 presents the descriptive statistics of our other explanatory variables. The figures are self-explanatory.

The estimation results of Equation (2) are presented in Table 4. We estimate both fixed and random effects models but report the results of the random effects model which is supported by Hausman test for Equation (2). The results presented in Table 4 reveal that the coefficient of *lnGFCF* is positive, as expected, and statistically significant. This indicates that a 1% increase in the share of GFCF as a percentage of GDP on average increases the size of the blue economy by 0.03% in Asia-Pacific Island countries. This finding implies that an increase in investment through better availability of roads and other infrastructure facilities would boost blue economic activities in Asia-Pacific Island countries. Further, the coefficient for *lnICT* is positive and statistically significant, which indicates that a 1% increase in mobile connectivity, on average, increases the size of the blue economy by 0.04%.

Table 2
Growth rates of blue economy activities in Asia-Pacific Island countries.

Country	Tourist Arrivals		Fisheries Production	
	Period I	Period II	Period I	Period II
Indonesia	−0.3	7.7	4.2	11
Philippines	3.0	6.8	4.1	−1.0
Sri Lanka	5.8	15	0.7	5.8
Papua New Guinea	2.3	6.7	18.8	2.4
New Zealand	4.5	2.5	1.4	−1.3
Timor-Leste	14.0	11.6	−0.2	3.7
Fiji	4.5	6.0	5.9	−0.6
Solomon Islands	1.0	4.7	−2.2	8.8
Brunei Darussalam	1.4	2.0	−6.6	16.2
Maldives	5.4	6.6	5.2	−1.1
Vanuatu	3.6	15.8	15.0	−14.6
Samoa	3.8	2.2	9.9	−4.6
Tonga	3.4	6.5	−0.2	−4.6
Federated States of Micronesia	0.7	3.4	5.2	15.5
Kiribati	0.7	4.9	−2.0	17.5
Marshall Islands	−0.6	−1.0	28.6	0.6
Palau	1.6	4.6	−0.9	−3.2
Nauru	–	–	−1.9	−7.5
Tuvalu	0.9	8.6	20.7	7.4

Source: The figures are based on compound annual growth rate; authors' own calculation.
Notes: Period I and period II refer to the periods from 1996 to 2007 and 2008 to 2016, respectively.

Table 3
Descriptive statistics.

	lnY_1	lnY_2	$ln\ Y_3$	lnFPRICE	lnEXPORT	lnGFCF	$lnCO_2$	lnELC	lnICT	POLICY	CRISIS	lnWORLD_IN	lnRP	lnEXG	lnTOT
Mean	19.85	10.38	4.10	1.49	9.27	2.49	0.30	3.48	2.24	0.63	0.45	9.09	−0.02	1.63	3.39
Median	19.06	10.62	4.18	1.53	10.20	1.95	0.00	4.38	2.87	1.00	0.00	9.11	0.00	0.58	4.39
Maximum	25.62	16.95	9.35	1.96	15.31	10.12	3.20	4.60	5.14	1.00	1.00	9.25	0.63	9.50	5.21
Minimum	15.50	5.7	−0.10	1.06	0.00	−2.39	−1.76	0.000	−4.86	0.00	0.00	8.90	−0.90	−0.03	0.00
Std. Dev.	2.37	2.85	2.65	0.26	3.73	2.96	1.12	1.66	2.19	0.48	0.49	0.10	0.18	2.31	1.97
Skewness	0.47	−0.16	−0.02	0.05	−1.02	0.70	0.90	−1.43	−0.63	−0.54	0.18	−0.16	−1.00	1.86	−1.09
Kurtosis	2.65	3.61	2.01	1.98	3.68	2.72	3.11	3.36	2.27	1.29	1.03	1.73	8.13	6.01	2.29
Jarque–Bera	14.22	8.43	16.86	18.22	82.09	36.31	57.54	145.34	37.38	71.20	69.68	29.82	52.13	40.84	91.84
Obs.	315	418	418	418	418	418	418	418	418	418	418	418	418	418	418

Notes: (1) Authors' own calculation. (2) For the reasons described in Section 2, we estimate Equation (2) for 15 countries; however, for the other two equations, we take into consideration 19 countries.

The estimation results presented in Table 4 reveal that, as expected, the coefficient of *lnTOT* is positive and statistically significant, which suggests that the higher the trade openness of a country, the higher will be the size of the blue economy. The coefficient of *lnTOT* is 0.01, which implies that a 1% increase in trade openness on average will increase the size of the blue economy by 0.01%. Hence, trade promotion policies in these countries would promote blue economic activity. Observe that ocean management policies such as the Pacific Island Regional Ocean Policy and the Sustainable Development Strategies for the Seas in East Asia have helped to enhance the size of the blue economy. The size of the blue economy in Asia-Pacific Island countries on average is 0.05% higher after implementation of these sustainable ocean management policies than before. We find that the GFC did not hamper the size of the blue economy on the whole in Asia-Pacific Island countries. This could be because the Asia-Pacific Island countries, especially the developing ones, were less affected by the GFC (Isgut, 2014). Though the initial impacts were quite significant (Kida, 2009; Kumar and Singh, 2011), many Asia-Pacific countries proved resilient to the GFC and recovered from the shock over time (Colmer and Wood, 2012; Isgut, 2014). Hence, on the whole, for our sample, we observe no adverse impacts from the GFC.

We employ alternative model specifications to check the robustness of our estimation results for determinants of the size of the blue economy, fisheries production, and tourist arrivals. The results obtained from alternative model specifications are presented in Appendix 2 (Tables A1, A2 and A3). We find that these results corroborate the results reported for our benchmark models specified in Equations (2)–(4).

Next, we estimate Equation (3) to understand the determinants of fisheries production in the Asia-Pacific Island countries; the results are shown in Table 5. We estimate the equation using both fixed and random effect models, however, the Hausman test supports the fixed effect model. Note that an increase in previous-year exports of 1% on average boosts fisheries production by 0.37%, which implies that if a country's fish exports increase, fisheries production will also increase to satisfy future export demand. The coefficient of GFCF has a positive and statistically significant effect on fisheries production, which indicates that a 1% increase in previous-year GFCF in the agricultural and fisheries sector on average leads to a 0.13% increase in the size of the blue economy. Access to electricity (*lnELC*) has a positive impact on fisheries production. Table 5 shows that a 1% increase in access to electricity on average will raise fisheries production by 0.11%. This finding is linked to powering the blue economy concept. It has been observed that in coastal areas, many marine industries are shifting towards inland areas as availability of electricity is greater in inland regions. The 'Powering the Blue Economy' initiative has emerged to address this issue and intends to assess the power requirements of emerging coastal and maritime markets and develop technologies that could integrate marine

Table 4
Determinants of size of blue economy in Asia-Pacific Island countries.

Variables	Coefficient	Std. Error	t-Statistic
lnGFCF (-1)	0.034**	0.017	1.990
lnELC	0.002	0.007	0.298
lnCO2	0.027	0.027	1.009
lnICT	0.043*	0.007	6.117
lnTOT	0.010***	0.006	1.678
CRISIS	0.138*	0.021	6.383
POLICY	0.052**	0.025	2.089
Intercept	19.51*	0.630	30.93
Overall R^2	0.68		
Hausman Test	Chi-square 6.87 (0.44)	Random Effect Model	

Notes: (a) Authors' own calculation; (b) *, **, and *** indicate 1%, 5%, and 10% levels of significance, respectively, (c) We estimate both fixed and random effects panel data models. But only the result of the model supported by the Hausman test is reported.
Data Source: FAOSTAT (2019), World Bank (2019).

renewable energy to relieve power constraints and promote economic growth.

Table 6 presents the estimation results of Equation (4), examining the factors which determine tourist arrivals in the Asia-Pacific Island countries. The Hausman test conducted for Equation (4) supports the random effect model presented in Table 6. Note that the coefficient of world income carries a positive sign and is statistically significant, which implies that a 1% increase in world income on average increases the number of tourist arrivals by 2.77%. Relative price (*lnRP*), which is a major determinant of competitiveness and sustainability, shows a negative sign and is statistically significant at the 1% level, which indicates that a 1% decrease in relative price in the home countries compared to other competing countries on average increases the number of tourist arrivals by 2.55% in the destination country. We believe that competitiveness and sustainability move hand in hand. Integration of sustainability into tourism policies is a fundamental step toward development of a sound and long-lasting tourism industry. For the sustainability of these island countries, prices should be very competitive.

The coefficient of the nominal exchange rate (*lnEXG*) is positive and statistically significant, indicating that a 1% depriciation in exchange rate on average increases tourist arrivals by 0.78%. The *POLICY* dummy signifying the sustainable ocean management policy implemented by the governments of Asia-Pacific Islands is positive and statistically significant, indicating that on average these policies can boost the number of tourist arrivals by 0.32%. This finding reiterates the importance of sustainable ocean management policies in enhancing tourism in Asia-Pacific Island countries. The coefficient of the *CRISIS* dummy is positive and statistically significant at the 1% level, which shows that the GFC did not hamper tourist arrivals in these island countries; rather, the number of inbound tourist arrivals improved by 0.26% in the post-crisis period. Basically, the GFC, which began in the US during the 2007–2008 period, did not affect these island countries, which might be because of their attractiveness as highly favoured tourist destinations. This is consistent with the results presented in Table 2.

To tackle any reverse causality in our estimation, we include the lag of key explanatory variables and perform a panel Granger causality test (pooled Ordinary Least Squares technique) for the variables used in estimating Equations (2)–(4). No evidence of reverse causality is found. The results of the Granger causality test are not reported here but are available upon request from the authors.

5. Conclusions and policy implications

The blue economy and its sustainability have emerged as a key research issue in recent decades and has become a buzzword among policy makers across the globe. Although a reasonable number of studies

Table 5
Determinants of fisheries production in Asia-Pacific Island countries.

Variables	Coefficient	Std. Error	t-Statistic
lnFPRICE(-1)	−0.058	0.184	−0.318
lnEXPORT(-1)	0.373*	0.034	10.997
lnGFCFA(-1)	0.128***	0.074	1.738
lnCO2	−0.010	0.062	−0.160
lnELC	0.108*	0.023	4.556
lnICT	−0.027	0.028	−0.969
POLICY	0.109	0.094	1.157
CRISIS	−0.140	0.122	−1.142
Intercept	6.458*	0.389	16.567
Overall R^2	0.97		
Hausman Test	Chi-square 16.83 (0.03)	Fixed Effect Model	

Notes: (a) Authors' own calculation (b) *, **, and *** indicate 1%, 5%, and 10% level of significance, respectively, (c) We estimate both fixed and random effects panel data models. But only the result of the model supported by Hausman test is reported.
Data Source: FAOSTAT (2019), World Bank (2019), International Monetary Fund (2020).

Table 6
Determinants of tourist arrivals in Asia-Pacific Island countries.

Variables	Coefficient	Std. Error	t-Statistic
lnWORLD_IN	2.770**	1.302	2.126
lnRP	−2.555*	0.333	−7.657
lnEXG	0.781*	0.162	4.813
lnCO2	0.083	0.105	0.791
lnTOT	−0.022	.034	−0.670
lnICT	−0.010	0.051	−0.202
POLICY	0.321***	0.180	1.780
CRISIS	0.260***	0.172	1.684
Intercept	−22.68	11.641	−1.948
Overall R^2	0.87		
Hausman Test	Chi-square 7.02 (0.53)	Random Effect Model	

Notes: (a) Authors' own calculation; (b) *, **, and *** indicate 1%, 5%, and 10% levels of significance, respectively; (c) We estimate both fixed and random effects panel data models. But only the result of the model supported by Hausman test is reported.
Data Source: World Bank (2019).

assess the blue economy from various perspectives, to the best of our knowledge, no study empirically examines the factors that drive the size of the blue economy. Thus, the present study attempts to identify the factors that determine blue economy activities by considering Asia-Pacific Island countries. To do so, we use annual data from 19 island countries for the 1996 to 2016 period. We find that the size of the blue economy in Asia-Pacific Island countries positively depends on GFCF and availability of ICT. This calls for higher investment in physical capital such as transport and storage and promotion of ICT by the governments of these island countries.

The role of ocean governance is often described as an important factor behind blue economy activity. We attempt to capture the impact of ocean governance policies like the Pacific Islands Regional Ocean Policy and the Sustainable Development Strategy for the Seas of East Asia by introducing a policy dummy in our analysis, showing a positive impact on the size of the blue economy. Further, we explore factors determining the output of two major blue economy sectors, fisheries and tourism. Our findings reveal the importance of more investment in the fisheries and agricultural sectors, better access to electricity, and better export opportunities as the major determinants of fisheries output. Our findings further show that world income, relative prices, depreciation of nominal exchange rate, along with policy and financial crisis dummies positively affect the size of the tourism sector. The positive influence of sustainable ocean management policies on the size of the blue economy reiterates the importance of these policies in strengthening economic growth in the Asia-Pacific Island countries.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix ASupplementary data

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Appendix 1

Country	Share of Blue Economy (as percentage of GDP)	Source
Indonesia	13%	PMSEA Report, retrieved from http://pemsea.org/sites/default/files/1475203802713042.pdf
Philippines	4.49%	PMSEA Report, retrieved from http://pemsea.org/sites/default/files/1475203802713042.pdf
Sri Lanka	9.4%	Kumara (2017)
Papua New Guinea	6.6%	Seidel and Lal (2010)
New Zealand	3%	MEC (2019)
Fiji	41.01%	Seidel and Lal (2010)
Solomon Islands	13.3%	Seidel and Lal (2010)
Maldives	36%	FICCI (2017)
Vanuatu	32.7%	Seidel and Lal (2010)
Samoa	25.45%	Seidel and Lal (2010)
Tonga	11.6%	Seidel and Lal (2010)
Federated States of Micronesia	26.2%	Seidel and Lal (2010)
Kiribati	36.2%	Seidel and Lal (2010)
Marshall Islands	62.4%	Seidel and Lal (2010)
Tuvalu	23.2%	Seidel and Lal (2010)

Notes: Compiled from different sources. Out of the 19 countries, we excluded Brunei Darussalam, Palau, Nauru, and Timor-Leste since they do not show a consistent data series for real GDP and share of blue economy.

Appendix 2

A1
Determinants of size of blue economy in Asia-Pacific Island countries – alternative model specifications

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
lnGFCF	+(**)	+(**)	+(**)	+(**)	–
lnELC	NS	NS	NS	NS	NS
lnCO2	NS	NS	NS	NS	NS
lnICT	+(*)	+(*)	+(*)	+(*)	+(*)
lnTOT	+(***)	+(**)	+(***)	–	+(***)
CRISIS	+(**)	–	+(*)	+(*)	+(*)
POLICY	+(**)	+(*)	–	+(**)	+(**)

Notes: a) Model 1 is the benchmark model; b) *, **, and *** indicate significance at the 1%, 5%, and 10% levels; c) NS means that the coefficient is not statistically significant; d) '+' and '-' denote the signs of the estimated coefficients.
Source: Authors' own calculation.

A2
Determinants of fisheries production in Asia-Pacific Island countries – alternative model specifications

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
lnFPRICE(-1)	NS	NS	NS	NS	NS
lnEXPORT(-1)	+(*)	+(*)	+(*)	+(*)	-
lnGFCFA(-1)	+(***)	+(***)	+(***)	+(***)	+(**)
lnCO2	NS	NS	NS	NS	NS
lnELC	+(*)	+(*)	+(*)	–	+(*)
lnICT	NS	NS	NS	NS	NS
POLICY	NS	NS	–	+(***)	+(*)
CRISIS	NS	–	NS	NS	NS

Notes: (a) Model 1 is the benchmark model; (b) *, ** and *** indicate significance at the 1%, 5% and 10% levels; (c) NS means the coefficient is not statistically significant; (d) '+' and '-' denote the signs of the estimated coefficients.
Source: Authors' own calculation.

A3
Determinants of tourist arrivals in Asia-Pacific Island countries – alternative model specifications

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
lnWORLD_IN	+(**)	+(*)	+(*)	+(**)	–
lnRP	-(*)	-(*)	-(*)	-(*)	-(*)
lnEXG	+(*)	+(*)	+(*)	+(*)	+(*)
lnCO2	NS	NS	NS	NS	NS
lnTOT	NS	NS	NS	–	NS
lnICT	NS	NS	NS	NS	NS
CRISIS	+(***)	–	+(***)	+(***)	+(*)
POLICY	+(***)	+(***)	–	+(***)	+(*)

Notes: (a) Model 1 is the benchmark model. (b) *, **, and *** indicate significance at the 1%, 5%, and 10% level. (c) NS means that the coefficient is not statistically significant. (d) '+' and '-' denote the signs of the estimated coefficients.
Source: Authors' own calculation.

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