Fisheries Research 108 (2011) 52–57

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Measuring productivity in fishery sector of Peninsular Malaysia☆

Gazi Md. Nurul Islam*, Kusairi Mohd Noh[1], Tai Shzee Yew[2]

Institute of Agricultural and Food Policy Studies, Putra Infoport, Jalan Kajang-Puchong, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

ARTICLE INFO

Article history:
Received 30 April 2010
Received in revised form
23 November 2010
Accepted 24 November 2010

Keywords:
Productivity
Fishing effort
Weighted CPUE
Tornqvist chain index
Peninsular Malaysia

ABSTRACT

This paper investigates the productivity of marine fisheries on the east and west coasts of Peninsular Malaysia for the period 1990–2005. Based on the data for landings and effort, weighted catch per unit of effort (CPUE) is computed for the trawl, purse seine and traditional fleets. The weighted CPUE differentiates the quality or composition of catch through weighting of the species mix in the catch by the share of total revenue of each species. Similarly, the various inputs that constitute fishing effort are weighted by their respective cost shares. The ratio of the Tornqvist chain catch and effort indices was used to measure intertemporal productivity changes in the respective fisheries. The results showed that the weighted CPUE was the highest for purse seine on the east and west coasts of Peninsular Malaysia. However, the productivity of purse seine fleet has not been tremendously increased over time. The productivities of trawl and traditional fleets on the east and west coasts were low. Restricting fishing effort through vessel limitation programs is viewed as a possible way of raising the productivities of these fleets. In addition, productivity increases can be achieved by enhancement of the resource stocks such as through the construction of artificial reefs.

1. Introduction

Productivity change is an important indicator to assess the performance of any industry. Productivity change in fisheries provides information on the level of fishing effort and fish catch to assess the competitiveness of the fishing industry. Changes in productivity of different fishing gears require changing regulations or policies to improve efficiency without corresponding increases in input used (Tai and Hussein, 1997). Productivity measurement can provide useful information regarding effective fishing effort, as opposed to nominal measures of effort such as catch per day at sea (Squires, 1994). Policy makers should be aware of the productivity trend to formulate effective fishery policies.

In this paper, we examine fisheries productivity on the east and west coasts of Peninsular Malaysia. The performance of the industry depends on the sustainable abundance of commercially valuable fish stocks. In the marine fisheries, productivity decline results in losses to fishing firms, employment and other fishing inputs. Several studies on productivity growth in marine fisheries were conducted by Norton et al. (1985), Herrick and Squires (1989), Kirkley (1984) and Davis et al. (1987). However, little is known about the productivity of the marine capture fisheries in Malaysia. Through this study, information on the level of fishing effort of various gear types and their productivity will be generated. Such information would be useful for sustainable marine fisheries management in Peninsular Malaysia.

2. Marine fisheries in Peninsular Malaysia

Diversity exists in the marine fisheries of Peninsular Malaysia. The sector is characterized by multi-stocks, multi-species and multi-gear. Diversity also exists due to geographical locations and environmental conditions. The fishing grounds on the west coast of Peninsular Malaysia are generally muddy and shallow, where fishing operations are highly capitalized. However, on the east coast of Peninsular Malaysia, marine conditions are slightly less favourable due to rough weather conditions during the monsoon season, between November and December. The seabeds off both coasts of Peninsular Malaysia are largely sedimentary and are suitable for trawling (Aglen et al., 1981). These characteristics are important for measuring fishery productivity in Malaysia.

An important characteristic of the marine fishery resources in Peninsular Malaysia is the presence of a large number of commercial species (about 70 species or species groups are listed in the Annual Fisheries Statistics of Malaysia). This large number of species can be broadly categorized into five groups: demersal, pelagic, crustacean, molluscs and mixed fish. The demersal finfish

☆ An earlier version of this paper was presented at the National Fisheries Symposium 2008, Terengganu, Malaysia, 14–16 July 2008.

* Corresponding author. Tel.: +60 3 8947 1093; fax: +60 3 8947 1077; mobile: +6 0162 448814.
E-mail addresses: gazinurul236@gmail.com (G.Md.N. Islam), kusairimn@gmail.com (K.M. Noh), sytai@putra.upm.edu.my (T.S. Yew).
[1] Tel.: +60 3 8947 1070.
[2] Tel.: +60 3 8947 1005.

0165-7836/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.fishres.2010.11.020

occupies and feeds close to the sea bottom, they do not traverse over a long distance. On the other hand, the pelagic fish inhabits the upper surface level of the sea. They are migratory in nature and have greater mobility compared to the demersal. The crustacean consists of various species of prawns and crabs while the molluscs are mainly made up of squids and octopuses. Mixed fish consists mainly of commercially less valuable species, including trash fish.

The fishing fleets of Peninsular Malaysia can be generally categorized into commercial and traditional fleets. The commercial fleet consists mainly of vessels operating trawl and purse seine gears, while traditional fleet operates traditional gears such as drift/gill nets, hook and lines, traps, and bag nets. The commercial fleets can be further classified by tonnage classes as specified in the Annual Fisheries Statistics of Malaysia which include: (1) less than 25 gross tonnage, (2) between 25 and 39.9 gross tonnage, (3) between 40 and 70 gross tonnage, and (4) greater than 70 gross tonnage. The catching power of the vessel in each tonnage class and gear type differs. These differences will have to be taken into account in productivity measurements. The number of trawl, purse seine and traditional fleets by tonnage classes are presented in Figs. 4–6.

3. Framework for measuring fisheries productivity

Productivity can be defined as changes in physical output per unit of input. Higher productivity means more output can be produced with the same bundle of inputs or conversely, the same output bundle can be produced from less input used.

Productivity growth in fisheries can be attributed to (1) changes in inputs used by existing firms depending on the state of exploitation of the fishery resource stock. Productivity will grow with increases in inputs used if the stock is under utilized. Conversely, growth in productivity can be achieved through reductions in inputs use (such as vessel buyback programs) if the stock is over exploited, (2) advances in technology, and (3) an increase in fishery resource abundance (Tai and Hussein, 1997). This study used a fishery production function framework for measuring productivity change. A general fishery production function is represented by Eq. (1) below.

$$Y_t = F(X_t;\quad A_t,\ B_t) \tag{1}$$

where Y_t is total landings at time t, $Xt = [X_{1t}, X_{2t}, \ldots, X_{nt}]$ is the input vector of ith input services such as labor and capital services at time t, A_t and B_t denote the level of technical knowledge and fishery resource abundance, respectively. The stock variable is not included in the empirical model of this study for two reasons: (i) stock data is not available; and (ii) abundance across gear types for a particular time period can be assumed to be the same.

A common measurement of fish productivity in the literature is the catch per unit of effort (CPUE), where effort is expressed in terms of number of vessels, number of fishers, fishing days, fishing trips or the composite of these inputs (Bell and Kinoshita, 1973; Anderson, 1987; Yahya and Yamamoto, 1988; Kusairi and Tai, 1988; Sharom, 1992; Yahya and Abdullah, 1993). This physical measure of productivity simply lumps together the total quantity of catch and the total fishing effort in one period and compares it with the total catch and effort from a subsequent period. Such measures of productivity fail to distinguish changes or differences in quality of catch and composition of effort over time because different products are being compared (Squires, 1988). This productivity measure is based on the implicit assumption for example, that a ton of pelagic fish caught by a purse seiner is perfectly substitutable for a ton of prawns caught by a trawler without considering the species caught, the value of the catch and the catching power of different gear types and vessel sizes (Tai and Hussein, 1997).

In this study, the productivity of the marine fisheries in Peninsular Malaysia is measured by using the weighted catch per unit of effort. It is estimated by dividing the total catch revenue by the total fishing costs. The ratio of weighted aggregate catch and effort constitutes the weighted catch per unit of effort expressed as:

$$\text{Weighted CPUE}_t = \frac{\Sigma_i R_{it} C_{it}}{\Sigma_j S_{jt} E_{jt}} \tag{2}$$

where R_i and S_j are revenue and cost shares respectively, C_i represents catch and E_j is fishing effort expressed in terms of number of vessels. The share of total revenue R_{it} is used to combine the different species groups into weighted measures of total catch, while the share of total cost S_{jt} can similarly be employed to aggregate different gear types and vessel sizes into a weighted measure of total effort (Jorgenson and Griliches, 1971). The use of cost shares as weights is to reflect the fact that bigger boats cost more to purchase and operate, not because they are bigger but because they are more productive in yielding higher returns. The weighted CPUE thus incorporates changes in the composition or quality of catch and effort. The productivity in this paper is measured in terms of aggregate and not for each species because catch per species is too small in the multispecies fisheries of Malaysia. It is assumed that there is no targeting behavior by fishers in Malaysia. Fishers catch whatever available species and market them at the prevailing prices.

The weighted catch per unit of effort can be used to compare productivity changes spatially and across gear types. Intertemporal productivity change can be used to compare productivity over time. Given the diverse outputs and inputs in the Malaysian marine fishery sector, intertemporal changes in productivity can be effectively measured by using economic index numbers rather than by physical measures. Economic index number takes into account the differences in composition or quality of the catch and inputs over time are non-dimensional and are completely independent from units of measurement.

Inter-temporal changes in productivity can be measured by the Tornqvist index (Tornqvist, 1936). The Tornqvist catch index is given by Eq. (3) as:

$$\left(\frac{Y_t}{Y_{t-1}}\right) = \prod\nolimits_i \left[\frac{Y_{it}}{Y_{i,t-1}}\right]^{0.5[R_{it}+R_{i,t-1}]} \tag{3}$$

where Y_{it} is the quantity of catch of species i at time t, R_{it} is the share of total revenue of catch i at time t, and Π_i is the product operator. The revenue shares, i.e. the proportion of total revenue for each species group, are used as weights. In practice, the Tornqvist catch index is usually constructed in logarithmic form for time periods t and $t-1$ as shown below:

$$\ln\left(\frac{Y_t}{Y_{t-1}}\right) = 0.5\sum\nolimits_i (R_{it} + R_{i,t-1}) \ln\left(\frac{Y_{it}}{Y_{i,t-1}}\right) \tag{4}$$

Similarly, the Tornqvist effort index in logarithmic form is calculated as:

$$\ln\left(\frac{E_t}{E_{t-1}}\right) = 0.5\sum\nolimits_j (S_{jt} + S_{j,t-1}) \ln\left(\frac{E_{jt}}{E_{j,t-1}}\right) \tag{5}$$

where E_{jt} is the quantity of input j at time t, and S_{jt} denotes the share of total cost of input j at time t. The indices calculated following Eq. (4) or Eq. (5) give the proportional rates of change (Tai and Hussein, 1997). The exponent of the results gives the actual level of the index as in Eq. (3).

In order to form indices, both fixed based and the chain methods can be used. The fixed based method directly compares all changes in productivity to some initial base period, which may or may not remain unchanged after some period of time. On the other hand, chain indices directly compare adjacent observations