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Performance of marine fishing industry in Karnataka : An analysis using total factor productivity

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ABSTRACT

Karnataka is a prominent maritime state in the south-west coast contributing 10.7% of the marine fish landings in India. Total factor productivity of marine fish production in Karnataka State for the period 2000 to 2010 was analysed using Divisia-Tornqvist indexing method. Quantities and revenue shares of 18 marine fish resource groups were taken for developing the output index and quantities and cost shares of fuel, labour and fixed capital were taken for developing the input index. Most of the marine fish resources including oilsardine, catfishes, lizard fishes, mackerel and cephalopods showed positive growth in landings during the study period. The output index, input index and total factor productivity growth were 6.2, 2.9 and 3.2 respectively and 51.69% of the output index growth was contributed by total factor productivity growth. This indicated the economic sustainability of marine fish production in the state in the short run period. The management mechanism existing in the state might have contributed to the sustainability of production system in the state.

Keywords: Divisia-Tornqvist index, Economic sustainability, Total factor productivity

Introduction

The state of Karnataka has a coastline of 300 km with 144 fishing villages and 96 fish landing centres. The marine fish landings in Karnataka increased from 1.8 lakh t in 2000 to 3.9 lakh t during 2011 (CMFRI, 2012). The landings are dominated by oilsardine (21%), mackerel (20%) and threadfin breams (9.5%). The gross earnings at point of first sales (at landing centres) increased from ₹467 crores in 2000 to ₹1,987crores in 2010 (Sathiadhas *et al*., 2012). There are three coastal districts in the state *viz*., Dakshin Kannada, Udupi and Uttar Kannada. The major harbours in the state are Mangalore, Malpe, Karwar, Tadri and Bhatkal. The major fishing units in the mechanised sector are trawlers, gillnetters and purse seiners. In addition, motorised and non-motorised units are also operating. The mechanised trawlers and purse seiners undertook both multiday and singleday fishing.

Various studies on the sustainability of marine fisheries in Karnataka reported that the fish production in the state increased during the 70s and 80s with the introduction of modern fishing gears and there was decline in the catch rates of major fishing gears like trawlers and purse seiners during the 90s and this has led to lower revenues and profits (Mohammed *et al*., 1998). Analysis of sustainability of marine fish production in Karnataka done by Bhat and Bhatta (2001) using Fox model showed that most of the species are harvested at very close to maximum sustainable yield levels and above the maximum economic yield.

The total number of mechanised units in the state increased from 3,243 in 1998 to 3,643 in 2010 indicating an overall increase of only 12.33%. However, with the introduction of high speed engines, many of the marine fishing units in the state started multiday fishing trips of up to 10 days duration. Even though this has contributed to increase in catches and revenue, this has resulted in high cost of fishing in terms of capital and fuel costs, which is evident from the increase in the quantity of diesel supplied to the marine sector through the cooperatives over the years. In this context, the present study was conducted in Karnataka State to assess the performance and economic sustainability of marine fishing industry using total factor productivity (TFP) analysis. Analysis of the TFP of marine fisheries will help to assess the economic sustainability of the production system.

Total factor productivity analysis was used to study the performance of many industries including marine fisheries. TFP is a measure of the productivity of all inputs or factors of production, in terms of their combined effect on output and is often accounted by technological change or more efficient methods of producing output. Index number approaches are commonly used for TFP measurements owing to less data requirements when compared to eononometric techniques. The estimates of TFP change in Indian agricultural sector using index numbers were done by many authors (Kumar and Mruthyunjaya,1992; Kumar and Jha, 2005; Mittal and Kumar, 2005; Thorat *et al*., 2006; Elumalai Kannan, 2011). However, TFP analysis in marine fisheries is very limited in India when compared to developed countries. The estimates of TFP change in marine fisheries using index number approach were done by Dale Squires for pacific coast trawl fleet (1988); Jin *et al.* in the New England groundfish fishery (2002); Hanneson in Norwegian fisheries (2007); Eggert and Tveteras in Icelandic, Norwegian and Swedish fisheries (2007); Dale Squires *et al.* (2007) for a panel of Korean tuna purse seine vessels in the Western and Central Pacific Ocean;TFP analysis of the Indian fisheries using Divisia-Tornqvist indices by Pradumankumar (2004) and Aswathy *et al.* (2013) in marine fisheries sector of Kerala.

Materials and methods

The species-wise growth in marine fish landings in Karnataka for the period 2000 to 2010 was analysed using compound annual growth rate (CGR). The total factor productivity of marine sector was done using Divisia-Tornqvist indices. The output and input indices were worked out for the period 2000 to 2010. The total factor productivity (TFP) implies an index of output per unit of total factor inputs and measures shift in output holding all inputs constant. Thus, TFP measures the amount of increase in total output which is not accounted by the increase in total inputs.

The output index is worked out as follows:

$$\text{Output index} = \Pi_j(Q_{jt}/Q_{jt-1})^{(Rjt+Rjt-1)1/2} \quad (1)$$

where Q_{jt} and Q_{jt-1} are the quantities of resource j at time t and t-1, R_{jt} and R_{jt-1} are the shares of resource j in total revenue at time t and t-1 and t is the number of years.

In each period, Q_{jt}/Q_{jt-1} in equation (1) gives the index relative to the previous period. A series of annual changes are aggregated together to express the index relative to a base year by multiplication. The input index is also worked out based on the following equation:

$$\text{Input index} = \Pi_i (X_{it}/X_{it-1})^{(Sit+Sit-1)1/2} \quad (2)$$

where X_{it} and X_{it-1} are the quantities of input i at time t and t-1, S_{it} and S_{it-1} are the shares of input i in total cost at time t and t-1 and t is the number of years (Kumar and Jha, 2005).

Secondary data on average quantities and prices of inputs in marine fisheries like fuel, labour and capital investment on fishing equipments were used to work out the input index. Quantities and revenue shares of 18 marine resource groups were used for developing the output index. The catch and fishing effort data from ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) for the period 2000-2010 was utilised for working out TFP in marine fisheries sector. The 18 resource groups which contributed to the total marine catch in Karnataka were considered for analysis and grouping was done to make the analysis easy. TFP index was worked out from the input and output indices for each year. Compound annual growth rate of TFP index measures the total factor productivity growth for the period under study. The quantity of diesel consumed was estimated based on the diesel subsidy given by the Department of Fisheries, the number of boats operated per year and discussion with fishermen. The labour days were estimated from the number of boats operated per year and the average number of workers in each category of fishing unit. The fixed capital was worked out based on the number of boats operated per year. Since the total factor productivity is influenced by government policies, TFP indices were worked out at subsidised and non-subsidised rates of HSD (high speed diesel) oil and comparisons were made. Even though the marine fish production is influenced by the stocks of individual resources and other natural factors in each year, these factors were not included in developing the input index due to lack of time series data.

Results and discussion

The results of the analysis on species-wise growth in marine fish landings, changes in the fishing fleet and their shares in gross revenue, labour days, fuel used and fuel subsidies and total factor productivity growth during 2000 to 2010 indicated positive total factor productivity growth of marine fisheries sector in the state.

Growth in fishing units and their share in gross value of catch

The total number of trawlers in Karnataka increased from 2,145 in 1998 to 2,515 in 2005 (17.25% increase) and again increased to 2,847 in 2010 (13.20% increase). The number of purse seiners increased from 463 to 505 (9.07%) and then declined to 422 (-16.44%) in 2010. The gillnetters increased from 633 to 1,254 (96.68%) and then reduced to 200 (-83.94%). The motorised units in Karnataka increased from 2,048 in 1998 to 3,705 in 2005 and again increased to 7,518 in 2010. The non-motorised units increased from 1,439 in 1998 to 7,577 in 2005 and then declined to 2,862 in 2010.

Analysis of the shares of different categories of fishing units in the gross revenue during 2000 to 2010 showed that the contribution of mechanised sector in the gross value of catch increased from 84.92 to 88.19% whereas that of motorised units declined from 12.64 to 10.71% and non-mechanised sector from 2.44 to 1.10%. Among the mechanised units in the year 2000, the mechanised trawlers contributed the maximum share at 56.6% followed by purse seiners at 27.5%. Motorised ringseiners and motorised gillnetters contributed 6.1% each. In 2010, the share of trawlers in the gross revenue increased to 70% whereas the share of mechanised purse seiners, outboard gillnetters and outboard ringseiners declined to18,4.11 and 4.64% respectively.

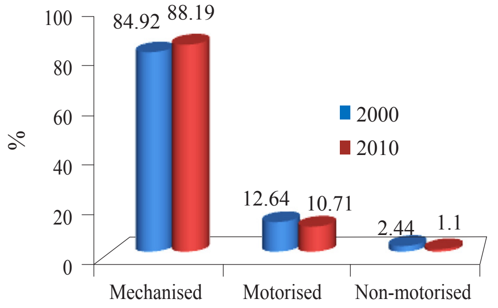

Fig. 1. Gear-wise share in the gross value of catch at first sales (2000-10)

Analysis of catch per hour of fishing by different fishing units showed negative growth for trawlers and non-mechanised units and positive growth for purse seiners and motorised units during 2000-2010 period. The trawlers contributed nearly 50-60% of the catch and purse seiners and motorised units together contributed 40-50% of the catch in various years during 2000-2010.

Growth in landings and shares in gross revenue of different species

Growth in landings of marine fishes during 2000 to 2010 showed that the growth rate was highest for catfishes at 23.88% followed by oilsardine (22.56%) and mackerel (12.73%). Lizard fishes showed a growth of 22.56%, barracudas, 12.56% and cephalopods, 11.01%. Tunnies, flat fishes and sharks showed negative growth in landings (Table 1). This is in contrast to the prediction and analysis

Table 1. Growth in landings of selected resources in Karnataka (2000-2010)

Name of species	Compound annual growth rate (CGR)(%)
Sharks	-3.64
Catfishes	23.88
Oilsardine	16.82
Lizard fishes	22.56
Perches	4.73
Croakers	6.42
Silverbellies	5.29
Flatfishes	-4.37
Clupeids	8.51
Ribbon fishes	10.41
Carangids	4.77
Pomfrets	0.65
Mackerel	12.73
Seerfishes	2.32
Tunnies	-11.54
Barracudas	12.56
Shrimps	3.13
Cephalopods	11.01
Total marine fish	9.02

of marine fishery yield in Arabian Sea off Karnataka over a period of 10 years from 1999-2001 by Mohammed and Zacharia (2009) indicating a decline in the key resources like mackerel, sardines, seer fishes within five years with consistent increase in fishing effort at 17% per annum. However sharks, tunnies and catfishes showed decline in catches which was in conformity with their analysis.

Analysis of the shares of different resources in the gross revenue showed that the share of penaeid shrimps increased from 23% in 2000 to 46% in 2002 and again declined to 22% in 2010. The share of cephalopods and mackerels increased from 13 to 19% and clupeids from 9 to 10% during 2000 to 2010. The share of perches declined from 10 to 8%, flat fishes from 5 to 2% and seer fishes declined from 11 to 6% during the period.

Inputs used in marine fishing sector

Labour, fuel and fixed capital were used for working out the input index in marine fisheries of Karnataka. The labour days were worked out based on the number of units and the average crew size for each category of craft. There was no drastic variation in the total labour used in marine sector during 2000 to 2010 period. This was due to the fact that the number of mechanised trawlers and purse seiners remained almost same during the study period, the number of mechanised gillnetters declined drastically and there was significant increase in the number of motorised units (Table 2). The labour days in the mechanised sector increased from 31.10 to 33.22 lakhs during 2000 to 2010. In the motorised sector, the labour days increased from 7 lakhs in 2000 to 13.9 lakhs in 2004 and then declined to 7.1 lakhs in 2010. In the non-mechanised sector, the labour days increased from 4.9 lakhs in 2000 to 5.7 lakhs in 2010. The labour cost consisted of crew share, bata and food for the crew. The total labour cost at constant prices (WPI 2005 = 100) increased from ₹183 crores in 2000 to ₹370 crores in 2010.

The total quantity of VAT exempted diesel consumed in the state increased from 48,682 kl (kilolitre) in 2002-03 to 1,15,000 kl in 2011-12 (Table 3). The quantity of VAT exempted diesel consumed was less than the actual amount sanctioned in most of the years from 2002-03 to 2011-12. The Government of Karnataka provided various subsidies to marine fishing sector consisting of reimbursement for HSD oil, VAT exemption and motorisation of traditional crafts. In addition, various other assistance schemes were also provided for the welfare of fishermen. The total amount of subsidy given for the motorisation of crafts increased from ₹9.95 lakhs in 2004-05 to ₹25 lakhs in 2008-09. The total amount of subsidy given for reimbursement of central excise duty was ₹400 lakhs and the amount of VAT exemption was ₹60 crores. The fuel cost comprised cost of diesel and

Table 2. Total labour days in the marine fishing sector in Karnataka

Years	Mechanised	Motorised	Non-motorised	Total
2000	3110579	700133	498327	4309039
2001	3088570	712605	646059	4447234
2002	3345447	1112356	699339	5157142
2003	3260429	789200	559668	4609297
2004	3096302	1396354	609162	5101818
2005	2692999	1301550	428694	4423243
2006	3329120	603265	518580	4450965
2007	3594492	867311	608202	5070005
2008	3342736	1138215	495999	4976950
2009	3028075	1006480	841803	4876358
2010	3322343	713970	571281	4607594
Average	3201008	940130	588828	4729968

Table 3. Supply of VAT exempted diesel in Karnataka through the fishermen cooperatives

Year	Quantity sanctioned	Quantity consumed
2002-2003	50000	48682
2003-2004	55000	49383
2004-2005	55000	53162
2005-2006	55000	51858
2006-2007	70000	59813
2007-2008	70000	63060
2008-2009	75000	72988
2009-2010	85000	85000
2010-2011	90000	95000

kerosene used in the fishing industry. The diesel cost at constant prices increased from ₹92 crores to ₹229 crores in 2010.

Total factor productivity with and without diesel subsidies

The total expenses in the marine fishing sector stood at ₹996 crores in 2010 which was 49% of the gross earnings at landing centre level (first sales). Labour cost accounted 50% of the total cost followed by fuel cost at 33%. The capital and ice costs together accounted the remaining 17% of the total cost. In Karnataka, the output index growth was 6.19% and input index growth was 3.2% and the total factor productivity growth was 2.88% without VAT exemption on diesel. With VAT exemption on diesel, the total factor productivity growth was slightly higher at 3.22% and 51.69% of the output index growth was contributed by total factor productivity growth (Table 4).

It could be concluded from the analysis that at current levels of catch and input use, the marine fish production in Karnataka is economically sustainable with positive total factor productivity growth. The total factor productivity growth during 2000-2010 period in Karnataka was higher than the TFP growth of Indian marine sector (2%) during 1987-98 period estimated by Kumar *et al.* (2004).

Table 4. Output, input and TFP indices of marine fishing sector in Karnataka (2000-2010) (with VAT exemption on diesel)

Years	Input index	Output index	TFP index
2001	100.00	100.00	100.00
2002	112.27	129.56	115.40
2003	105.10	117.86	112.13
2004	114.55	116.81	101.97
2005	106.28	156.51	147.27
2006	109.82	133.80	121.84
2007	121.19	151.32	124.87
2008	127.18	173.43	136.36
2009	131.37	148.83	113.29
2010	131.51	203.58	154.80
CGR (%)	2.9	6.2	3.2

The estimates of TFP change in the New England ground fish fishery done by Di Jin *et al.* (2002) showed that the TFP increased on an average 4.4% per annum during 1964 to 1993 and the highest average increase occurred during 1964-1982 possibly due to new technologies like fish finders. The total factor productivity of Commonwealth trawl fishery for the period 1996-97 to 2009-10 indicated that TFP fell by 1.9% per year during 1996-2005, but during 2005-10 TFP increased 6.6% per year which was due to slight decline in input index since 2005-06 with considerable improvements in outputs (Perks *et al*., 2011).

Measures of productivity and technical change give important information on the performance of an industry. TFP shows positive growth when vessels are adopting innovations such as improved gear design (technical change), electronics or when the vessels and skippers use their economic inputs more efficiently so that they catch more fish with the same capital, labour and harvesting technology (technical efficiency). The total factor productivity of marine fisheries in Karnataka showed that the marine fishery in the state is economically sustainable with positive TFP growth in the short run period. Many of the marine fish resources and overall marine fish landings showed positive growth during the study period from 2000 to 2010. The diesel subsidy scheme in the state has supported the mechanised fishermen. However, the analysis showed that the fishing industry is able to survive even without diesel subsidy as indicated by the positive TFP at non-subsidised rates of HSD oil. Kempuraju (1992) reported the existence of several self-imposed regulatory mechanisms in Karnataka through the fishermen societies for avoiding conflicts and to manage the capture fishery in the state. Addition of new crafts in the fishery is restricted in the state through the fishermen societies and replacement of existing ones alone is possible in many of the harbours. The efficiency in some of the fishing units such as purse seiners and motorised units, positive growth in overall resource stock, government policies and local mechanisms for fisheries management might have contributed to the positive growth in output and positive overall TFP growth in the state. However the declining catch per hour of trawlers cautions for better management measures and improving the efficiency of this fishing gear for ensuring the bio-economic sustainability of marine fisheries in the state.

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