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Methodological Tools for Socioeconomic and Policy analysis in Marine Fisheries

ICAR-Central Marine Fisheries Research Institute
Post Box No: 1603, Emakulam North P.O.
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ICAR-CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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About the Cover page

The cover page portrays the diversified role the social science could play in assessing the socio-economic and policy analysis in marine fisheries sector – on environment, fishes and fisheries, fishers and institutions.

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Foreword

Marine fisheries is fast expanding its frontiers that necessitates rigorous research on a variety of aspects that include sustainable management of fishery resources, optimum utilization of fishing effort, stock dynamics, bio-economic equilibrium and related aspects, diversity of marine biota, impact of climate change on marine ecosystem, prospective sources of future growth, policy aspects and so on. In this endeavor, social sciences play a major role in understanding and delineating the inter-linkages of human behavior vis-à-vis the environmental and biological processes in the realm of marine fisheries. It is important to understand the social and economic processes that define and propel fishing as an economic activity that provides livelihoods to over 40 lakhs of coastal inhabitants in the country. A stream of topics that encompasses valuation of marine fish landings, bio-economic evaluation of stock dynamics, economic assessment of capital investments and fishing efforts, estimation of total factor productivity, market dynamics, technology transfer, gender-mainstreaming and related studies therefore reserve their importance in better understanding marine fisheries as a multi-disciplinary domain of science.

I am happy that the SEETT Division of CMFRI has taken a lead in developing a manual on "Methodological Tools for Socioeconomic and Policy Analysis in Marine Fisheries" which is an earnest effort from the Division in lucidly presenting the most common techniques which could be used in assessing the complexities of the marine fishery sector. I hope that this manual would play a fruitful role in presenting the relevance of socio-economic concepts and tools in better understanding the marine fishery sector, particularly by specialists in other disciplines leading to better integration between social and biological sciences in marine fisheries research. I complement the editors and the contributors for taking the initiative and wish them all success in their future endeavors.

14.02.17
Cochin

A. Gopalakrishnan
Director, CMFRI

Preface

Social sciences in general and fisheries in particular have a pivotal role to play in the fisheries development Until recently the biological sciences and social sciences were independent with limited integration leading to the lower level of adoptions of the technologies by the end users. The recent trend in developing inter and multi-disciplinary research initiatives has ensured that the research developments/ outputs gets to the end user in the shortest time and in the end with an exit strategy of where they can apply to on a day to day basis. Fisheries sector hosting a gamut of entrepreneurship venture corroborates the importance of technical knowhow in project planning, formulation and implementation. Fish business can never shrug off away from its economics phenomenon operating in the present scenario. The socio-economic concerns of fisher folk; environmental resource economics; export concerns, marketing and international trade and the like opened new vistas of thoughts under fisheries and economics and the importance of going hand in hand in developing new techniques in fishery research.

The manual titled "Methodological Tools for Socioeconomic and Policy analysis in Marine Fisheries" includes fourteen chapters which are centred among four major areas which are integral part in fishery research like marketing and valuation of fish landings; the development indices and gender improvements of the fishers; the role of the financial institutions in assessing the viability of the fishery business and the environment surrounding the fishery resources relating to climate change and vulnerability. These are being dealt with a view that researchers from non-economic background without the help of social scientists can do a justifying work to their research.

We are thankful to the Director, CMFRI who wholeheartedly supported in publishing the manual and we extend our sincere thanks to all the contributors division with the timely support extended during the preparation of the manual. I wish that this manual will meet the requirements and expectations and would serve as a useful handbook to researchers of fishery science.

14.02.17 **Editors**

Cochin

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List of Acronyms

ADAK	Agency for Development of Aquaculture, Kerala
AC	Average Cost
AFC	Average Fixed Cost
AVC	Average Variable Cost
BARS	Behavioural Anchored rating scale
BEP	Break even Point
BEQ	Break Even Quantity
BSBDA	Basic Savings Bank Deposit Account
BSNL	Bharat Sanchar Nigam Limited
CAD	Computer Aided Design
CIFT	Central Institute of Fisheries Technology
CLV	Customer Lifetime Value
CMFRI	Central Marine Fisheries Research Institute
CPU	Central Processing Unit
CRM	Customer Relationship Management
CSR	Corporate Social Responsibility
CVP	Cost Volume Profit Analysis
DEA	Data Envelopment Analysis
DPH	Days Post Hatch
DVPM	Department of Avian Production and Management
EQ	Emotional Quotient
FFDA	Fish Farmers Development Agency
GI	Galvanized Iron
GIGO	Garbage In Garbage Out
HAB	Harmful Algal Bloom
HACCP	Hazard Analysis Critical Control Point
HDPE	High Density Poly Ethylene
HTTP	Hypertext Transfer Protocol
ICAR	Indian Council of Agriculture Research
ICT	Information and Communication Technology
IGMSY	Indira Gandhi Matritva Sahyog Yojana
IISER	Indian Institute of Science Education and Research
IMPS	Immediate Payment Service

INSPIRE	Innovation in Science Pursuit for Inspired Research
IQ	Intelligence Quotient
ISP	Internet Service Provider
LCM	Least Cost Method
LODOS	Low Dissolved Oxygen Syndrome
LPP	Linear Programming Problem
MBO	Management By Objective
MC	Marginal Cost
MCTS	Mother and Child Tracking System
MoS	Margin of Safety
MP	Moist Pellet
MPIN	Mobile PIN
NGO	Non Governmental Organization
NMEW	National Mission for Empowerment of Women
NPCI	National Payment Corporation of India
NWCM	North West Corner Method
PMJDY	Pradhan Mantri Jan-Dhan Yojana
POSEC	Prioritizing by Organizing, Streamlining, Economizing and Contributing
QLIM	Qualitative and Limited Dependent Variable Model
RAM	Random Access Memory
RD	Recurring Deposit
RMK	Rashtriya Mahila Kosh
ROM	Read Only Memory
SAF	Society for Assistance to Fisherwomen
SHG	Self Help Group
SMART	Specific, Measurable, Achievable, Realistic, and Timely
STEP	Support to Training & Employment Programme for Women
SWOT	Strengths, Weaknesses, Opportunities and Threats
TL	Total Length
URL	Uniform Resource Locator
USP	Unique Sales Proposition
VAM	Vogel Approximation Method
VDU	Visual Display Unit
WIFI	Wireless Signal
WWW	World Wide Web

1

ECONOMICS OF FISHING OPERATIONS, FINANCIAL FEASIBILITY AND SENSITIVITY ANALYSIS

R. Narayanakumar, Shyam S. Salim and M.S. Madan

Concept

Economics is the basis for life. Every one of us is a practicing economist in himself/herself in life. The principle of economics, when applied to fields like agriculture, animal husbandry, fisheries, poultry and other enterprises becomes more valuable. Initially fisheries did not consider economics as a component. But later in course of time, the fishery biologists realized that economics is a vital component of fisheries management.

The economic principle says that wants are unlimited but the means to satisfy them are limited. This is the basis of scarcity definition of Economics. In the wider sense, the resources at our disposal to meet our requirements are limited. We have to allocate the resources among the competing alternatives, for which the economic theory helps us. Optimization of resource use to obtain maximum profit is one of the aims for applying economic principle in entrepreneurship. In fisheries also, the economic principles are allocated for formulating fisheries management measures.

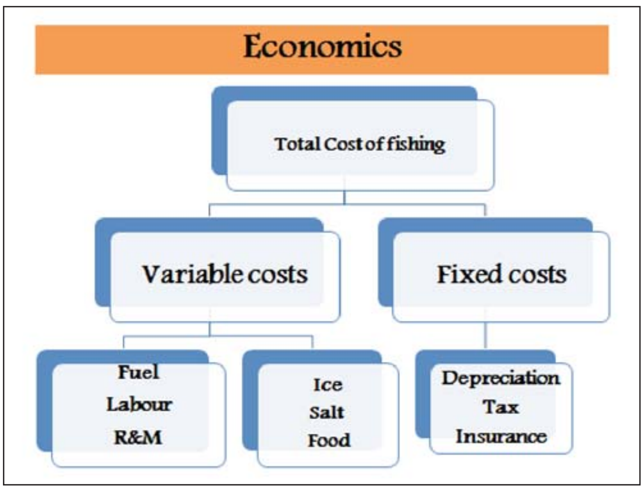
Costs of fishing operations

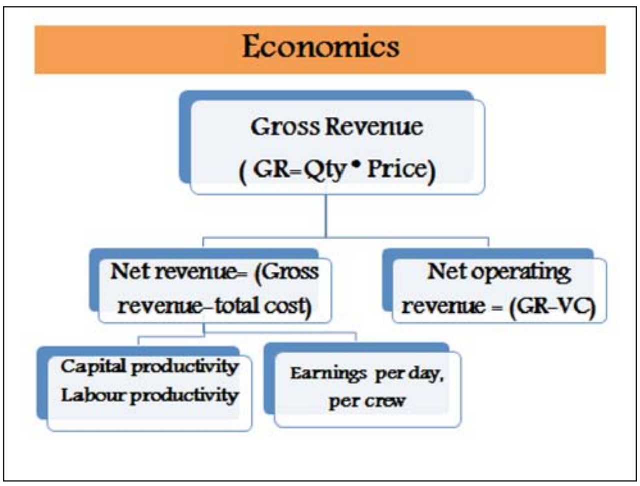
The costs of fishing operations are divided into fixed costs and operating costs.

Fixed cost

Fixed costs (normally referred as annual fixed costs) refer to the expenses that are met even if there is no fishing and are recurring in nature. Example: taxes, insurance premium, permanent labour (if any). In addition to the above, the annual fixed costs include, depreciation, interest on fixed capital (as an opportunity cost of capital).

The depreciation of all the components of fishing craft and gear are worked out based on their economic life. The relevant details are collected from the detailed questionnaire designed for this purpose. (See Annexure-1). The normal rates of depreciation followed are 8 per cent per annum for mechanised crafts, 10





per cent for motorized and traditional crafts (hull alone). The gears depreciate at 33 per cent and the minor equipments which are replaced every year is depreciated at 50 per cent. The engines, winch motors, iron ropes are depreciated at 10 per cent assuming an economic life of 10 years. The electronic gadgets like GPS are subjected to a depreciation rate of 20 per cent. The interest on fixed capital is normally worked out based on the interest rate charged for long term loans by Nationalised banks, which are refinanced by National Bank for Agricultural and Rural Development (NABARD).

Variable Costs (VC)

Variable costs refer to the out of pocket expenses and also the actual expenses incurred in the process of production (Figure 1). The variable costs include the labour wage, daily *bata,* fuel cost, cost of ice, expenses on food, repair and maintenance charges and other incidental costs.

In mechanised fishing, the labourers normally are paid the wages per week which can be converted into per trip. The labourers will also be paid daily *bata* as a proportion of the gross revenue, which will be included in the operating costs. In case of motorized and traditional and traditional units, the labourers normally share the catch in lieu of wages. In such cases the crew share can be computed after deducting the expenses from the gross revenue. Of the remaining amount, a certain proportion (ranging from 35 to 50 per cent depending upon the craft and gear used) will be allocated as the craft's share to meet the expenses and the remaining amount is equally shared among all the crew members including the owner. The imputed value of family labour should be computed based on the wages for hired labour. The wages for the family labour so derived should be added to the total wages while calculating the operating costs

The fuel cost per trip should be calculated by multiplying the quantity of diesel/ kerosene consumed per trip with the price per litre. The expenses on lubricating oil which normally will be incurred weekly, should be converted to expenses per trip. The repair and maintenance charges, normally expressed per annum, which included the maintenance charges of crafts, engines and gears, should be apportioned per trip. It is customary to consider the interest on working capital in agricultural enterprises as there will be a substantial time lag between use of variable inputs and the time of realization of output. However, in case of marine fishing, the expenditure on variable inputs like fuel, food, lubricating oil and other expenses is incurred and the returns realized on the same day. Hence, the interest on working capital need not be included.

Gross returns(GR)

The return per trip can be calculated by multiplying the species-wise quantity collected per trip with the corresponding landing center price of the species (Figure 2). The gross returns per trip can be converted to gross returns per season by multiplying gross returns per trip with the number of trips per season. Later this can be scaled up to annual value by adding the values of all the seasons.

The gross returns per trip can be calculated using the formula

$$\text{Gross return per trip} = \sum_{i=1}^{n}(P_i X_i)$$

Where,
Pi is the landing center price of the i^{th} species,
X_i is the quantity of the i^{th} species caught and
'n' is the number of species caught per trip.

Net returns (NR)

The annual net return is worked out by subtracting the annual total cost from annual gross returns.

Annual Net Return (Profit/Loss) = [Gross revenue-(Annual Fixed cost +Annual Variable cost)]

The calculation of cost and returns are given in the following table. This is based on the work done in Ramanathapurpam district of Tamilnadu.

Table 1 Annual Fixed cost of mechanised fishing unit (*in Rupees)*

Components of fixed cost	Value	Per cent to total
1. Depreciation		
a. Craft	37,064	55.31
b. Engine	6,958	10.38
c. Gears	10,587	15.8
d. Major accessories	9,803	14.63
e. Minor accessories	2,598	3.88
Total depreciation	**67,010**	**45.15**
2. Interest on initial investment @ 18 % per annum	81,410	54.85
3. Total annual fixed cost	**1,48,420**	**100**

Table 2 Annual Operating cost of a mechanized fishing unit *(in Rupees)*

Particulars	Mechanized craft	
	Value	Per cent to total
1. Number of fishing days	229	
2. Number of fishing trips	125	
Operating Cost		
1. Wages	78,704	14.08
2. Fuel	3,68,110	65.88
3. Food & daily bata	40,005	7.16
4. Ice	17,471	3.13
5. Lubricating oil	7,989	1.43'
6. Auction	-	-
7. Repairs and maintenance	46,271	8.28
8. Berthing	198	0.04
9. Others	-	-
10. Annual operating cost	5,58,748	100

Table 3 Annual cost and returns of a mechanized trawl fishing unit *(in Rupees)*

Particulars	Mechanized crafts	
	Cost /return	Per cent to total
1. Annual fixed cost	1,48,420	20.99
2. Annual operating cost	5,58,748	79.01
3. Annual total cost	**7,07,168**	**100**
4. Annual catch (in kg.)	56,326	
5. Annual gross revenue	7,91,159	
6. Annual net operating income (5-2)	2,32,411	
7. Annual net income (5-3)	83,991	

Productivity of fishing units

Productivity measures the economic efficiency of a particular system. This is a measure of how different inputs are utilized efficiently. To estimate the productivity of major fishing units, different economic indicators like rate of return, returns to labour and capital, break-even harvest and price, pay-back period and related indicators can be worked out sector-wise for mechanised, motorised and traditional fishing units

Operating ratio	= [Annual operating cost / Gross return]
Fixed ratio	= (Annual fixed cost /Gross Return)
Gross ratio	= (Annual total cost /Gross return)
Capital turnover ratio	= (Gross return/ Initial investment)
Break-even harvest (tonnes/annum)	= Fixed cost/ (Price per kg -variable cost per kg)
Break-even price (rupees/kg)	= [Total cost of harvest (in rupees)/Annual harvest (in kg)]

This will also help to analyse the comparative economic efficiency of different types of fishing units.

The productivity of mechanised fishing unit based on our studies conducted in Tamil Nadu is given below.

Table 4 Comparative productivity of fishing units, Tamil Nadu

Economic indicators	Traditional crafts	Motorized crafts	Mechanized crafts
A. Input-Output Efficiency			
1.Operating ratio	0.812	0.805	0.706
2. Fixed ratio	0.232	0.182	0.188
3. Gross ratio	1.044	0.987	0.894
B. Capital Efficiency			
1. Capital turn-over ratio	1.586	2.062	1.749
2. Rate of return on capital (%)	21.75	30.26	49.61
3. Pay-back period (years)	4.6	3.31	2.02
C. Labour Efficiency			
1. Number of crew employed	2	4	5
2. Average production per manday (kg.)	9.86	32.74	163.98
3. Value of production per manday (Rs.)	255.54	770.48	2303.23
4. Average wages per manday(Rs.)	113.55	279.67	229.12
D. Break-even Analysis			
1. Break-even harvest (tonnes)	2.82	14.36	35.92
2. Break-even price (Rs.)	27.04	23.23	12.55
3. Average price realised (Rs./kg.)	25.91	23.54	14.05
E. Other Measures			
1. Average annual fishing days	234	235	229
2. Average catch per day (kg.)	9.86	65.47	245.97
3.Gross revenue per day(Rs.}	255.54	1540.96	3454.84
4.Net operating income per day (Rs.)	48.05	300.55	1014.89
5. Net profit per day(Rs.}	-11.18	20.01	366.76

Financial feasibility of fishing units

The financial feasibility of fishing units is an important analytical tool that determines the financial worthiness of the crafts. Hence the financial institutions are interested to see the economic viability of any enterprise before advancing loans to them. The financial feasibility of fishing units can be studied through investment evaluation using both discounted cash flow techniques and undiscounted cash flow techniques.

The undiscounted cash flow measures include:

Rate of return on capital = (Average annual cash flow/ Initial investment) x 100

Pay-back period (years) = (Initial Investment / Average annual cash flows)

Discounted cash flow techniques

These techniques have a relative advantage since the expected future cash flows are reduced to a single sum at a point of time by incorporating the time value of money. The different criteria that were employed to evaluate the investments are:

(i) Net present Value (NPV),

(ii) Benefit-Cost ratio (BCR)

(iii) Internal Rate of Return (IRR)

The feasibility analysis of fishing methods is based on a few assumptions, which include, the following assumptions:

1. The rate of interest on fixed capital is 12 percent per annum.
2. Costs and benefits are assumed to remain at the level obtained in the initial year since the effect of inflation on cost will be offset by the inflation in the output prices over years.
3. The annual number of fishing days are assumed to be 220 for mechanized crafts, 240 for motorized and 260 for traditional crafts.
4. The additional expenses on nets is added to the investment every third year.
5. The economic life of the mechanized crafts can be assumed to be 10 years and that of traditional and motorized crafts to be 15 years.
6. The salvage value was assumed to be 10 per cent of the initial investment.

Net Present Worth (NPV)

This criterion helps to determine the present net worth of the stream of cash inflows over cash outflows. The streams of cash flow should be discounted at the selected interest rate. This discount rate can be selected based on some criteria like the World Bank suggested interest rate for evaluating the projects related to agriculture and allied sectors. NPW is calculated using the following formula:

$$NPW = \sum_{n=0}^{T} B_n (1+d)^{-n} - \sum_{n=0}^{T} C_n (1+d)^{-n} + V_T (1+d)^{-T} - \sum_{n=0}^{T} I_n (1+d)^{-n}$$

Where,

B_n = Cash inflows in period n
C_n = Cash outflows in period n

V_T = The salvage value realized in the terminal year of the investment
I_n = Investment made in year n
d = Discount rate
n = Number of years of economic of investment
T = Terminal year

The ranking guideline is that, for an investment to be feasible, the NPW should be positive.

Benefit Cost Ratio (BCR)

The ratio of the sum total of annual discounted net cash flows over the economic life of the investment indicates the benefit-cost ratio. This ratio should be equal to or greater than unity for the investment to be considered feasible. The BCR is computed as follows;

$$\text{BCR} = \frac{\sum_{n=0}^{T} B_n (1+d)^{-n} - \sum_{n=0}^{T} C_n (1+d)^{-n} + V_T (1+d)^{T}}{\sum_{n=0}^{T} I_n (1+d)^{-n}}$$

Internal Rate of Return (IRR)

IRR is that discount rate which makes the NPW equal to zero. It can be said that, IRR is that discount rate which equates the net cash flows during its economic life with the initial investment. This represents the average earning capacity are the compound rate of earning of the investment. The mathematical form of IRR is written as:

$$\text{IRR} = \sum_{n=0}^{T} B_n (1+r)^{-n} - \sum_{n=0}^{T} C_n (1+r)^{-n} + V_T (1+r)^{T} - \sum I_n (1+r)^{-n} = 0$$

Where, r = internal rate of return

The actual procedure to calculate IRR is by linear interpolation.

$$\begin{aligned} &\text{IRR} \\ &= \text{Lower discount rates} \\ &+ \text{Difference between the two rates} - \frac{\text{NPW at lower discount rate}}{\text{Absolute difference between the NPWat the two}} \end{aligned}$$

Here the lower discount rate (LDR) is that rate at which NPW is positive and higher discount rate (HDR) is that rate at which NPW is negative. Care has been taken to minimize the effect of linearity by choosing the LDR and HDR which are as close as possible so that the calculated IRR should be greater than the investor's required rate of return or opportunity cost.

The financial analysis can be done using MS Excel sheet itself. The factors for year-wise discount rates can be arrived at using the formula $1/(1+r)^n$.. (Please refer the excel sheets for actual calculations (A model table is given below).

Table 5 Financial Feasibility Analysis of a mechanized craft

Year	Investment	Cash out flow	Total cash out flow*	Discount factor (20%)	Discounted cash outflow (DCOF)	Cash inflow**	Discount factor (20%)	Discounted cash inflow (DCIF)	Discounted Net cash flow	
0	37710.86	0	37711	1.0000	37711	0	1.0000	0	-37711	
1		48553	48553	0.8333	40461	59796	0.8333	49830	9369	
2	1387.99	48553	49941	0.6944	34681	59796	0.6944	41525	6844	
3	7890.11	48553	56443	0.5787	32664	59796	0.5787	34604	1940	
4	1387.99	48553	49941	0.4823	24084	59796	0.4823	28837	4753	
5		48553	48553	0.4019	19512	59796	0.4019	24031	4518	
6	9278.1	48553	57831	0.3349	19368	59796	0.3349	20026	658	
7		48553	48553	0.2791	13550	59796	0.2791	16688	3138	
8	1387.99	48553	49941	0.2326	11615	59796	0.2326	13907	2292	
9	9278.1	48553	57831	0.1938	11208	59796	0.1938	11589	381	
10	1387.99	48553	49941	0.1615	8066	59796	0.1615	9657	1592	
11		48553	48553	0.1346	6535	59796	0.1346	8048	1513	
12	9278.1	48553	57831	0.1122	6486	59796	0.1122	6707	220	
13		48553	48553	0.0935	4538	59796	0.0935	5589	1051	
14	1387.99	48553	49941	0.0779	3890	59796	0.0779	4657	768	
15		48553	48553	0.0649	3151	62937	0.0649	4085	934	
					277519			**279778**	2259	
								NPV at 20% discount rate	4518	2259
								BCR at 20% discount rate		
								Discounted cash inflow		279778
								Discounted cash outflow		277519
								BCR (DCIF/DCOF)		**1.01**

Sensitivity Analysis

Sensitivity analysis is a simple technique to assess the effects of adverse changes on a project. It involves changing the value of one or more selected variables and calculating the resulting change in the NPV or IRR. The extent of change in the selected variable to test can be derived from post evaluation and other studies of similar projects.

Changes in variables can be assessed one at a time to identify the key variables. Possible combinations can also be assessed.

Sensitivity analysis should be applied to project items that are numerically large or for which there is considerable uncertainty.

The results can be presented together with recommendations on what actions to take or which variables to monitor during implementation and operation.

Practical Utility

- It forces management to identify the underlying variables and their relationships.
- It shows how robust or vulnerable a project is to change in underlying variables.
- It indicates the need for further work in terms of gathering information in NPV or IRR is highly sensitive to changes in some variables.

Limitations:

1. It may fail to provide leads - if sensitivity analysis merely presents complicated set of switching values it may not shed light on the characteristics of the project.
2. The study of impact of variation in one factor at a time, holds other factors constant, may not be very meaningful when underlying factors are likely to be inter-related.

Data requirement

Cost and benefit stream across the project time period anticipated is required.

Methodology:

Sensitivity analysis can be done to ascertain the project feasibility at three different stages.

(i) ***Increasing cost of capital or interest rate increases***

The increasing cost of capital or the interest rate increases can be accounted in the sensitivity analysis by computing the NPV and BCR at different discount rates and thereafter checking the profitability of the changes.

(ii) ***Escalation of cost of the project due to different risks involved***

The cost of the projects gets escalated due to the various risk factors involved in the business which include the prophylactic measures needed to control and prevent the disease outcome, application of more fertilizers than the expected, more number of irrigations, more number of man days increase due to the inefficiency of human labour, etc. This increase in the cost of the project can be accounted by the ex-ante approach of increasing the project cost by 10 percent and 20 percent and later working the NPV and BCR with the benefit stream keeping unchanged.

(iii) ***Uncertainties resulting due to differences in the price receivables***

The uncertainties in the project benefit stream arise due to the uncertain nature of the prices that are expected in the market after the harvests. The uncertainties are basically due to the reason that the factors determining prices itself are subjected to changes. The other uncertainties include the yield uncertainty, technological uncertainty and institutional uncertainty. In countering the uncertainties, the anticipated benefit stream in the project can be reduced by 10,20,30 percentages and the NPV and BCR are computed accordingly, keeping the project cost unchanged.

Example :

For the following fisheries project data set on the perform the sensitivity analysis for the three different cases of :

(i) Increasing cost of capital.

(ii) Increased cost of project due to risks involved at 10 and 20 percent cost like.

(iii) Uncertainties due to the differences in the price receivables at 10, 20 and 30 percent reduction for the yield.

Table 6 Case -I : Increasing Cost of Capitals

Year	Cost	Benefit	d.f. at 12%	d.c. at 12%	d.b. at 12%	d.f. at 20%	dc at 20%	d.b at 20%	df at 25%	d.c. at 25%	db. At 25%
0	250000	0	1	250000	0	1	250000	0	1	250000	0
1	50000	200000	0.893	44650	178600	0.833	41650	166600	0.800	40000	160000
2	50000	200000	0.797	39850	159400	0.694	34700	138800	0.640	32000	128000
3	50000	200000	0.712	35600	142400	0.579	28950	115800	0.512	25600	102400
4	50000	200000	0.636	31800	127200	0.482	24100	96400	0.410	20500	82000
5	50000	250000	0.567	28350	141750	0.402	20100	100500	0.328	16400	82000
				430250	749350		399500	618100		384500	554400
				NPV	319100		NPV	218600		NPV	169900
				BCR	1.714		BCR	1.5471		BCR	1.4418

Inference:

The computation of the NPV and BCR at different cost of capital indicates that the project is feasible and profitable even at 25 per cent discount rate. At 25 percentage discount rate also there exists a positive NPV and BCR of more than one. The exercise indicates the high yielding capacity of the project even at higher discount rates.

Table 7 Case II : Escalation of the cost of the project due to the different risks involved

Year	Cost	Bene-fit	d.f at 12%	d.c. at 12%	d.b. at 12%	Cost increase by 10%	d.c. at 12%	d.b. at 12%	Cost increase by 20%	d.c. at 12%	db. at 12%
0	250000	0	1	250000	0	275000	275000	0	300000	300000	0
1	50000	200000	0.893	44650	178600	55000	49115	178600	60000	53580	178600
2	50000	200000	0.797	39850	159400	55000	43835	159400	60000	47820	159400
3	50000	200000	0.712	35600	142400	55000	39160	142400	60000	42720	142400
4	50000	200000	0.636	31800	127200	55000	34980	127200	60000	38160	127200
5	50000	250000	0.567	28350	141750	55000	31185	141750	60000	34020	141750
				430250	749350		473275	749350		516300	749350
				NPV	319100		NPV	218600		NPV	169900
				BCR	1.742		BCR	1.547		BCR	1.442

Inference:

On increasing the cost of the project taking into consideration the different risks involved the computed NPV and the BCR values indicate that the project is feasible and economical to a discount level rate of even when there is an increase of 20 percentage cost increase.

Table 8 Case III : Uncertainties resulting due to the differences in the price receivables

Year	Cost	Benefit	d.f at 12%	d.c. at 12%	d.b. at 12%	Reduction in benefit of 10%	Discounted benefit	Reduction in benefit of 20%	Dis-counted benefit	Reduction in benefit of30%	Dis-coun-ted benefit
0	250000	0	1	250000	0	0	0	0	0	0	0
1	50000	200000	0.893	44650	178600	180000	160740	160000	142880	140000	125020
2	50000	200000	0.797	39850	159400	180000	143460	160000	127520	140000	111580
3	50000	200000	0.712	35600	142400	180000	128160	160000	113920	140000	99680
4	50000	200000	0.636	31800	127200	180000	114480	160000	101760	140000	89040
5	50000	250000	0.567	28350	141750	225000	127575	200000	113400	175000	99225
	500000	1050000		430250	749350	945000	674415	840000	599480	735000	524545
				NPV	319100	NPV	244165	NPV	169230	NPV	94295
				BCR	1.742	BCR	1.567	BCR	1.393	BCR	1.219

Inference:

The uncertainties in the project benefit stream can be sensitised by the exante approach of reducing the anticipated project benefit stream at 10,20, 30 percentages. The computed NPV and BCR ratios indicate that the project can withstand uncertainties to the tune of even 30 per cent reduction in the yield due to the different uncertainties. The NPV and BCR at 30 percentage reduction in the yield in the project benefit stream was found to be Rs. 9,4295 and 1.21 respectively.

Annexure-I

Socio Economic Evaluation and Technology Transfer Division
Central Marine Fisheries Research Institute, Cochin-682 018
Schedule 1: Fixed cost and fishing pattern

1. **Type of Fishing Unit** : Mechanized

   Primary gear: Secondary gear:

2. **Reg. No.** :
3. **Landing Centre** :
4. **Location** ***Mandal /Taluk*****:** **District:** **State:**
5. **Ownership information**
   a) Name and address of the owner :
   b) Type of ownership : Sole/Partnership/Family/Others
   c) Source of Finance : Self/Bank/Coop society/Private. Source/ Others (specify)

      Amount (Rs.): Subsidy if any(Rs):

   d) Year of Purchase :
   e) New one or second hand :
   f) If second hand, age of the craft at the time of purchase:

6. Technical information

Sl.No.	Components	Specifications			
1	Hull (Craft)	OAL (ft):	Wood/ Steel	Breadth(ft):	Draft (ft) :
2	Engine	Make:		Hp:	Fuel : (Lit/hr):
3	Gear	Head rope (m):		Cod end mesh:	
4	Fish holding capacity (tonnes):				

7. Fishing Pattern details

Seasons	Pre- monsoon	Monsoon	Post- monsoon
Mention Period			
Type of fishing:(SDF/MDF)			
No. of trips/Year			
Fishing days / week			
Voyage hours/ trip			
Actual fishing hours/trip			
Fishing Holidays			
Closed seasons			
Dry docking for Repairs & Maintenance. (no. of days)			
Major fishing ground(Lat/ long. position)			

Note: SDF: Single Day Fishing; MDF: Multi Day Fishing

8. Investment details (in Rupees)*

Sl.No.	Components	Specifications	Purchase value	Year of Purchase	Economic Life	Subsidy(Rs.)
1.	Hull (Craft)					
2.	Cost of fiber coating					
3.	Engine					
4.	Winch set					
5.	Otter board					
6.	Fish hold (cold storage units)					
7.	Ropes					
8.	Wireless sets					
9.	Eco sounders					
10.	GPS set					
11.	Batteries					
12.	Wire rope					
13.	Propeller					
14.	Gears/ Net (1)					
	Gears (2)					
	Gears (3)					
	Gears (4)					
	Gears (5)					
	Gears (6)					
	Gears (7)					
	Gears (8)					
	Gears (9)					
15.	Other accessories (Specify)					
	Total					

Note: * Whichever item is applicable for a particular craft, please fill in the respective column.

9. Other fixed cost components

a) Insurance premium

b) Taxes (if any)

c) Others

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2

TOTAL FACTOR PRODUCTIVITY (TFP): THEORY AND APPLICATIONS

Aswathy N.

Concept

Total factor productivity 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 for by technological change or more efficient methods of producing output.Technological change is the major determinant of long term economic growth and hence Total Factor Productivity growth serves as an indicator of the long-term growth in an economy.

There are different arguments on what total factor productivity actually measures. The conventional view is that TFP measure the rate of technical change (Law (2000) Krugman (1996). Total factor productivity of an economy increases only if more output is produced from a given supply of inputs. Improvements in technology clearly increase total factor productivity.TFP measures all improvements in technology, including such things as the introduction of electricity, motorcar or technological progress leading to increased agricultural output or rapid technological shocks that are associated with information and communications technologies (ICTs). The second argument suggests that TFP measures only externalities and other free gifts associated with economic growth. According to this view, the incomes generated by higher productivity are external to the economic activities that generate growth and these benefits spill over to income recipients not involved in these activities (Jorgenson, 1995).

The basics of total factor productivity measurement- The aggregate production function

Technological progress or growth of total factor productivity is estimated as a residual from the aggregate production function.The aggregate productivity, mean the productivity of unique entities such as nations or entire industries.

Consider the simple Cobb-Douglas version of the aggregate function:

$$Y = AL^{\alpha}K^{\beta}, \alpha + \beta = 1$$

Total aggregate output is measured as *Y. L* is an index of aggregate labour inputs. *K* is an index of aggregate capital. *Y, L* and *K* are independently measured while *A*, α and β are statistical estimations. *A* is an index of the aggregate state of technology called total factor productivity. But changes in the number indicate shifts in the relation between measured aggregate inputs and outputs and in this aggregate model these changes are assumed to be caused by changes in technology (or changes in efficiency and/or in the scale of operations of firms).

The geometric index version of TFP is calculated by dividing both sides of the production function by L^{α} to produce a measure of TFP:

$$TFP = A = \frac{Y}{L^{\alpha}K^{\beta}}$$

The growth rate measure of TFP is then calculated as an arithmetic index generated by taking time derivatives of both sides of the TFP expression. L to the power alpha and K to the power Beta are the shares of output/

income accruing to labour and capital.

$$\alpha = \frac{wL}{Y}$$
$$\beta = \frac{r\,K}{Y}$$

Where w is wages paid to labour, and r is the real rental rate of capital.

$$\frac{wL}{Y} + \frac{r\,K}{Y} = 1$$

Changes in A indicate shifts in the relation between measured aggregate inputs and outputs. In the aggregate model these changes are assumed to be caused by changes in technology (or changes in efficiency and/or in the scale of operations of firms).

There are some conceptual and empirical problems concerning the measurement of TFP. These relate to the following issues: (1) a relevant concept of capital, (2) measurement of output, (3) measurement of inputs, (4) the place of R&D and public infrastructure, (5) missing or inappropriate data, (6) weights for indices. (7) theoretical specifications of relations between inputs, technology and aggregate production functions, (8) aggregation over heterogeneity.

Approaches to measure TFP

The approaches to total factor productivity measurement are generally classified into frontier and non-frontier approaches. The non- frontier approaches consists of parametric and non- parametric methods. The growth accounting and indexing procedure comes under the non -parametric approach. Programming and econometric approaches are included under the parametric methods (Figure 1).

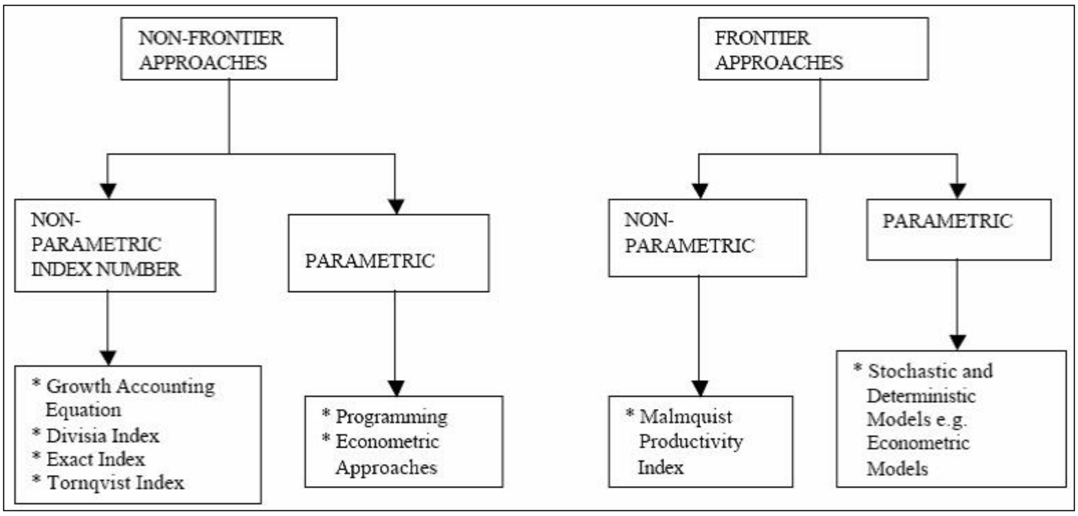

Figure 1. Methodological approaches for TFP measurement: An illustration

There are different indexing methods for calculating the total factor productivity. Some of the most common of these are the Laspeyres index, the Paasche index, the Fisher index and the Tornqvist index. Most work on TFP uses a Tornqvist index, which is basically a percentage change index that averages base and given years weighted indexes. The Tornqvist quantity index is defined as the product across all goods of the ratio of current quantities divided by base year quantities weighted by the average of the base year and current year prices. The Tornqvist index is considered 'superlative' because of its capacity to approximate general functional forms of the production function. Tornqvist index is a discrete approximation to a continuous Divisia index. A Divisia index is a weighted sum of the growth rates of the various components, where the weights are the component's shares in total value. For a Törnqvist index, the growth rates are defined as the difference in natural logarithms of successive observations of the components and the weights are equal to the mean of the factor shares of the components in the corresponding pair of periods. The Törnqvist index represents an improvement over constant base-year weighted indexes, because as relative prices of inputs change, the Törnqvist index allows both quantities purchased of the inputs to vary and the weights used in summing the inputs to vary, reflecting the relative price changes (Lipsey and Carlaw, 2001).

When TFP is calculated from a macro production function, the quantities used are the aggregate capital stock and the aggregate labour supply; when it is calculated from industry data, they will be industry capital and industry labour; similarly for firms, it will be each firm's capital stock and its employed labour. To get the basic quantities without any prior aggregation, extremely detailed micro data would be needed with a separate quantity input for each capital service. Thus, no matter how disaggregated are the physical quantities that are used for any calculation of a TFP index, they are typically aggregated over some group of heterogeneous capital goods (or capital services) by converting them to values. National productivity estimates are of special importance because they are an integral part in public policy making. However at this level of aggregation, the data available are limited to fairly short time series, which limits the scope for econometric estimation. As a consequence, index number methods are most commonly employed for measuring TFP. Most studies have used the index number approach to measure productivity growth due to its simplicity and lower data requirements when compared to complicated econometric models.

Total factor productivity-an application to the marine fisheries sector in Karnataka using Divisia Tornqvist indexing method

TFP index = $\frac{\text{Output index}}{\text{Input index}}$

$$\text{Input index} = \prod_i (X_{it} / X_{it-1})^{(S_{it}+S_{it-1})^{1/2}}$$

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

Similarly output index was workout as follows:

$$\text{Output index} = \prod_j (Q_{jt} / Q_{jt-1})^{(R_{jt}+R_{jt-1})^{1/2}}$$

Where, Q_{jt} and Q_{jt-1} are the quantities of resource j at time t and t-1

R_{jt} andR_{jt-1} are the shares of resource j in total revenue at time t and t-1

t is the number of years (Kumar and Jha,2005).

Construction of input and output indices

The total factor productivity indices were developed for marine fishery sector in Karnataka based on the input and output indices calculated for the period 2000 to 2010. Fuel and labour used in the fishery were used for developing the input index. Secondary data on average quantities and prices of inputs in marine fisheries like fuel, labour, and quantities and revenue shares of 18 resource groups for the period 2000-2010 from Central Marine Fisheries Research Institute (CMFRI) was utilized for working out TFP in marine fisheries sector. Compound Annual Growth Rate of TFP index measures the total factor productivity growth for the period under study. The quantity of diesel consumed was obtained from 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 fuel used in the fishing industry was estimated based on average fuel consumption per hour of operation for all the fishing units. The data was validated by using total diesel sales data from the different diesel pumps, data from fishermen societies and information on diesel subsidy given by various state departments of fisheries. The data on kerosene was estimated based on the number of motorized units operated per year and average kerosene consumption per fishing trip. Labour employed in the marine fishing industry (Mechanized/motorized/Non-mechanized sectors) was estimated in terms of labour days (Table 1). The fixed capital was estimated from the number of boats and investment details on each category of fishing unit.

Labour used in marine fishing industry was estimated in terms of number of days employed per worker per annum. The labour consists of three categories- mechanized, motorized and non-motorized. The mechanized category included vessels of less than 20 m OAL, which used mechanization both for propulsion as well as for fishing operations. The motorized category consisted of outboard motor fitted boats and non- mechanized category consisted of traditional wooden canoes without any engine.

Table 1. Aggregate quantities of inputs used in marine fish production

States	Total Labour days	Diesel (L)	Kersone (L)
2000	4309039	51638328	4327720
2001	4447234	46628536	4941030
2002	5157142	48682000	6151550
2003	4609297	49383000	5626750
2004	5101818	53162000	7250780
2005	4423243	51858000	6991980
2006	4450965	59813000	4958430
2007	5070005	63060000	7023770
2008	4976950	72988000	10209350
2009	4876358	85000000	9209350
2010	4607594	95000000	7209350

The share of inputs in gross value was worked out based on the assumption that these variables contribute more than 80 percent of the total input cost. The sum of input shares should be equal to 1.The aggregate input quantities were weighted by the inputs shares to develop the input indices for each year.

Similarly output indices were worked out based on the quantities and shares in the total revenue of the resource groups consisting of sharks, catfishes, lizard fishes, perches, croakers, silverbellies, flatfishes, clupeids, ribbonfishes, carangids, pomfrets, mackerels, seerfishes, tunnies, barracudas, shrimps and cephalopods. The TFP index for each year is worked out as ratio of output index to input index expressed as a percentage. The growth in input, output and TFP indices for the period 2000 to 2010 was worked out using compound annual growth rate (Table 2).

Table 2. Estimated input, output and TFP indices of marine fishery sector in Karnataka

Years	Input index	Output index	TFP index
2000-01	100.00	100.00	100.00
2001-02	112.91	129.56	114.74
2002-03	104.65	117.86	112.62
2003-04	115.41	116.81	101.22
20004-05	104.11	156.51	150.32
2005-06	108.94	133.80	122.82
2006-07	121.14	151.32	124.92
2007-08	128.55	173.43	134.91
2008-09	134.85	148.83	110.37
2009-10	136.07	203.58	149.61
CGR	**3.22**	**6.20**	**2.88**

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3

VALUATION OF FISH ACROSS THE SUPPLY CHAIN

Shyam S. Salim and Safeena P. K.

Definition

Valuation of fish includes assigning monetary value to the produce across the locations where it land .The valuation attains significant changes owing to the place, form, time and type of product. Economic valuation provides a means for measuring and comparing the various benefits of fisheries resources. Economic impact assessment, through monitoring landing centers and fish markets to estimate output volume and value based on prices.

Utility

Valuation provides an insight into the price realized at the different levels of fish marketing. The valuation takes into account the numerous complexities involves in the spatial, temporal and species. The valuation of landings also provides an idea on the revenue generated by the fish across the value chain. It requires relatively little data and no formal sampling. It has good potential for reliability and scaling-up and requires comparatively little time for processing data. Demands on local capacity are modest, and expertise may be strengthened quickly with relatively simple training.

Data set required

Quantity of fish traded across the landing centres (point of first sale) and retail centers (point of last sale) across time periods with its prices realised .

Methodology

The methodology adopted for the arriving at the valuation of the fish across the different point of sales involves the following steps.

Step I-Sampling design
Step II-Developing schedules
Step III-Data collection
StepIV-Analytical Tools

Step I-Sampling design

India has a coast line about 8219km. Marine fish landings take place almost all along the coastal line throughout the day and sometimes during night. According to marine fisheries census 2010, there are 3288 fishing villages scattered along the coast line from where fishermen go for fishing and return to a landing centre which may be distinct from the fishing village. There are 1511 landing centres scattered along the coastline of the main land. Under these conditions collection of data by complete enumeration is expensive and time consuming, so from each maritime state, sample landing centres are selected based on the proportion of landings and the nearby retail markets were selected for collection of data. These centers could change based on the quantum of landings and relevance.

Step II-Developing schedules

There are schedules developed the collection with a vernacular support for data entry at field level called MAP (market price) and the prices released according to size are collected using a manual developed. The data are tabulated and processed

Step III -Data collection

Trained field staff was deployed on a weekly/ fortnightly basis to collect data on prices and count of different species from selected landing centres and retail markets. The mean prices across seasons and year are computed to arrive at the valuation estimates. .In arriving at valuation estimates the prices realized and are considered outliers due to abnormal suppy / demand were denoted in the schedules and often not considered while arriving at mean prices.

Step IV -Analytical Tools

Conventional tabular, percentage and ratio analysis could be used wherever necessary. The other analytical concepts used are described below.

A) Valuation of marine fish landings

The growth and development of fisheries sector greatly depends on the revenue or income earned from the sector and the income earning potential in the future. The gross revenue earned from the marine fish landings at maritime state level and national level were worked out separately. The valuation was done at two points namely landing centre level and retail centre level. Also we have four layers of valuation namely Valuation of Species (VS_i), Periodic wise valuation (VP_j), Location wise valuation (VL_k) and Aggregate State/ Country valuation (V)

1. Valuation at species level

   Let S_{ijk} denote species i of j[th] period at k[th] location, then

   $$VS_i = \sum_{j=1}^{m} \sum_{k=1}^{l} VS_{ijk} \quad ; \text{i=1,2…n(species)}$$

   Where $VS_{ijk} = Q_{ijk} * P_{ijk}$; j=1,2…m(months/week)z
   k=1,2….l(state/centres)

   Q_{ijk} is quantity of species i in j[th] period at k[th] location and

   P_{ijk} is price of species i in j[th] period at k[th] location

2. Valuation at Location level

   $$VL_k = \sum_{i=1}^{n} \sum_{j=1}^{m} VS_{ijk} \quad ; \text{ k=1,2…l(locations)}$$

3. Valuation at periodic level

   $$VP_j = \sum_{i=1}^{n} \sum_{k=1}^{l} VS_{ijk} \quad ; \text{j=1,2…m(periods)}$$

4. Valuation at Aggregate level

   $$V = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{l} VS_{ijk}$$

Work out example

Given below are tables representing the data set on the quantity of fish landed and traded across the point of first sales during 2014 and 2015 across the coastal states.

Table 2- Valuation of aggregate marine fish landings representing location and periodicity

Landing Centre Valuation						
Location	Period 2014			Period 2015		
	Quantity (t)	Aggregate Average price of all species (₹)	Total species valuation (crores)	Quantity (t)	Average price of all species (₹)	Total species valuation (crores)
Andhra Pradesh	3,41,699	69.86	2387	295,052	103.30	3,048
Gujarat	7,11,930	83.74	5962	721,549	97.39	7,027
Karnataka	4,74,076	75.20	3565	442,693	104.29	4,617
Kerala	5,75,644	121.86	7015	482,499	198.43	9,574
Maharashtra	3,44,648	96.19	3315	264,891	174.64	4,626
Tamilnadu	6,65,858	70.60	4701	709,337	79.43	5,634
Goa	1,53,230	55.80	855	68,561	154.61	1,060
Puducherry	65,393	17.59	115	79,148	24.01	190
West Bengal	76,536	136.15	1042	1,18,650	102.82	1,220
Orissa	1,38,722	160.03	2220	1,41,120	175.74	2,480
Daman Diu	46,097	124.30	573	81,271	76.29	620
Total	35,93,835	88.35*	**31,750**	34,04,771	117.76*	**40,095**

*Average price

Table 2- Valuation of oil sardine landings (species level) in India during the year 2014 - 2015.

Location	Period 2014			Period 2015		
	Q_{ijk}(tonne)	P_{ijk} (₹)	VS_{ijk}(crore)	Q_{ijk}(tonne)	P_{ijk} (₹)	VS_{ijk}(crore)
Kerala	1,55,087	45.01	698	68431	65.03	445
Karnataka	143,494	43.97	631	43489	49.67	216
Maharashtra	30,039	54.93	165	16841	72.44	122
Tamilnadu	77,409	21.06	163	87553	22.04	193
Andhra Pradesh	11,957	18.40	22	23622	27.09	64
Odisha	582	68.73	4	406	73.89	3
Gujarat	6,891	21.77	15	2053	29.23	6
West Bengal	40	70.00	0.28	NA	NA	0
Goa	1,22,046	39.98	488	16212	49.96	81
Total	**5,47,545**	**39.92***	**2,186**	**2,58,607**	43.65	**1,129**

*Average price computed based on total valuation and landings

Interpretation of results
The Table I indicate the average price realized across the states and is computed for estimating the valuation of landings at the point of fist sales. It has been found that

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4

CONSTANT MARKET SHARE AND PRICE SPREAD ANALYSIS

Shyam S. Salim, Ramees M. Rahman and Athira P. Rethnakaran

Introduction

A market share is something defined on the basis of the total share of a company out of total segment sales, which can be either through the volume or value dealt by the company. Market share is much significant as it indicates the consumers' preference for a product over other similar products. A higher market share announces the strength of the company, higher sales, lesser efforts to win the market and strict barriers for the competitors to entry.

The constant market share (CMS) analysis, formerly referred to as the change caused by the changes in competitiveness, demonstrates the development of the competitiveness and the structure of market share of a country. It compares the actual export growth performance of a country with the performance that would have been achieved if the country had maintained its exports relative to some standard. The analysis is usually carried out to quantify the export performance of a country compared to the rest of the world. A country which exports to market that is growing slower than the world average or a product which has its demand growing slowly than average, can have a decrease in its aggregate market share even if it maintains its market share. Hence, according to constant market shares analysis the exports should oriented towards the most dynamic markets and products in the world trade.

Theoretical background

Tyszynski in 1953 had done pioneering works by using the constant market share (CMS) analysis which made it popular in applied international economics. The analysis is based on the assumption that a country's share in world markets should remain constant over time. The basic identity of the CMS analysis is:

$$q^t = \sum_p q_p^t = \sum_p s_p^t \, Q_p^t \qquad (1)$$

or alternatively:

$$s^t = \sum_p s_p^t \, S_p^t \qquad (2)$$

Where q^t = aggregate exports of the focus country

q_p^t = exports of the p-th commodity of the focus country

Q_p^t = world exports of the p-th commodity

s^t = aggregate exports share of the focus country in total world exports

$s_p^t = \frac{q_p^t}{Q_p^t}$, share of the p-th commodity of the focus country in the p-th commodity of world exports.

$S_p^t = \frac{Q_p^t}{\sum_p Q_p^t}$, share of the p-th commodity of world exports in the total world exports.

t = time.

The simplest formulation of CMS analyses can be obtained by differentiating Identity 2 with respect to time:

$$\frac{ds^t}{dt} = \sum_p s_p^t \frac{dS_p^t}{dt} + \sum_p S_p^t \frac{ds^t}{dt} \qquad (3)$$

In Identity 3 the growth of the aggregate export share of the focus country $(\frac{ds^t}{dt})$ is decomposed into two elements: a structural effect due to changes in commodity shares in the world trade $(\sum_p S_p^t \frac{ds^t}{dt})$, and the competitiveness effect $(\sum_p s_p^0 \Delta s_p \Delta S_p)$, which measures the changes of the focus country's exports due only to export share changes in each commodity. Tyszynski suggested to use year 0 weights to measure the structural effect at constant market shares and year 1 weights to compute the competitiveness component, whereas Baldwin in 1958 employed year 0 weights to compute both the competitive and the structural effect which leaves a residual1 interacting between the structural and the competitive term.

In 1971, Richardson interpreted the residual term $(\sum_p s_p^0 \Delta s_p \Delta S_p)$ as a second measurement of competitiveness, since it would indicate whether the country was increasing its export shares in rapidly growing commodities and markets. He combined Laspeyres- and Paasche-type systems of weights in order to assure consistency in the accounting for changes in the total exports.

In 1988, Milana applied the discrete-time decomposition in the case where the CMS analysis is expressed in terms of absolute changes of the country's exports. The system of weights in this version is calculated using an average of the weights of the initial and final year. This choice reflects the fact that a country's export structure and total world trade are changing over time, but that there is no reason to believe that either the structure at the beginning- or end-of-period was dominant throughout the period.

The structural term of the CMS analysis was formulated by Merkies and van der Meer in 1988. Later various eminent personalities used the technique to compare the competitiveness. In 2000, Simonis analyzed the Belgium foreign sector by comparing the country's competitiveness with its main trading partners. Fagerberg and Sollie applied the same in 2002, over a sample of 20 industrialized countries between 1961 and 1983. The study done by Holst and Weiss in 2004 was also based on the same analysis by focusing on the export rivalry of the ASEAN members and China.

Practical Utility

The constant market share (CMS) analysis is meant to shed light upon the export performance of a country and thereby to reveal the underlying reasons of the comparative export performance. The export performance is analyzed by allowing achieved export growth to be separated into commodity, market-distribution, and competitiveness effects. The method can be well used to evaluate whether the country's comparative performance have grown in line with its competitors as well as to figure out the exporting level of the country with relatively favorable or unfavorable growth rates. The analysis can be considered as a technique figure out pattern and trend of trade for the purpose of policy formulation.

Keywords: *Constant market share, international trade, applied economics, market share, export performance.*

Software support

The analysis can be done in MS Excel.

Data requirement

- Export details of the selected product of the selected country, over the years
- Export details of other countries, in case comparison is needed.
- Import details of the selected product of the importing country.

Methodology

The export growth under CMS analysis is considered as co-impact of four factors namely global market growth effect, commodity composition effect, market share effect and change in competitiveness. The export data of the country can be decomposed into structural, competitive and second order effects according to the following formula;

$$\Delta Q_{kij} = S_{kij}^{0} \times \Delta Q_{kij} + Q_{kij}^{0} \times \Delta S_{kij} + \Delta S_{kij} \times \Delta Q_{kij}$$

Where,

$S_{kij}^{0} \times \Delta Q_{kij}$ is structural effect

$Q_{kij}^{0} \times \Delta S_{kij}$ is competitive effect

$\Delta S_{kij} \times \Delta Q_{kij}$ is second order effect.

'D' is the changeover period, '0' is the base period, '1' is the final period, 'Q' is the value of product exports, 'S' is the share of exports in value terms.

The decomposition formulae and definitions of different components of growth of exports under constant market share analysis is presented in Table 1. The analysis covers the export details over a period of time in order to figure out the export performance and changes in competitiveness

Table 1. Decomposition Formulae and Definitions of Different Components of Growth of Exports Under Constant Market Share Analysis

Main component	Sub component	Formula	Definition
Structural effect	Growth effect	$S_{K}^{0} \times \Delta Q$	Δ in total product exports of country 'k' due to changes in the world's total exports
	Market effect	$S_{kij}^{0} \times \Delta Q_{kij} - S_{ki}^{0} \times \Delta Q_{ki}$	Δ in exports of country 'k' of product 'i' to country 'j' due to change in market distribution of exporting country.
	Commodity effect	$S_{kij}^{0} \times \Delta Q_{kij} - S_{kj}^{0} \times \Delta Q_{kj}$	Δ in exports of country 'k' of product 'i' to country 'j' due to change in commodity composition of exporting country.
	Interaction effect	$(S_{kij}^{0} \times \Delta Q_{kij} - S_{ki}^{0} \times \Delta Q_{ki}) - (S_{kij}^{0} \times \Delta Q_{kij} - S_{kj}^{0} \times \Delta Q_{kj})$	Δ in exports of country 'k' of product 'i' to country 'j' due to interaction in market and commodity effects.
	Sub total	$S_{kij}^{0} \times \Delta Q_{kij}$	Δ in exports of country 'k' of product 'i' to country 'j' due to change in export value to export destination 'j'.
Competitive effect	General competitive effect	$Q^{0} \times \Delta S_{k}$	Δ in exports of country 'k' of product 'i' to country 'j' due to a change in competitiveness of country 'k' for total exports to the world.
	Specific competitive effect	$Q_{kij}^{0} \times \Delta S_{kij} - Q^{0} \times \Delta S_{k}$	Δ in exports of country 'k' of product 'i' to country 'j' due to a change in competitiveness of country 'k' in export of product 'i' to destination 'j'.

	Sub-total	$Q^0_{kij} \times \Delta S_{kij}$	Δ in exports of country 'k' of product 'i' to country 'j' due to a change in exporting country's market share of product 'i' in a export destination 'j', i.e., competitiveness.
Second order effect	Pure second order effect	$(\frac{Q^3}{Q^0} - 1) \times \Delta S_{kij} \times \Delta Q_{kij}$	Δ in exports of country 'k' of product 'i' to country 'j' due to interaction of specific competitive effect and structural effect.
	Dynamic structural residuals	$\Delta S_{kij} \times \Delta Q_{kij} - (\frac{Q^3}{Q^0} - 1) \times \Delta S_{kij} \times \Delta Q_{kij}$	Δ in exports of country 'k' of product 'i' to country 'j' due to interaction of specific competitive effect and market effect
	Sub-total	$\Delta S_{kij} \times \Delta Q_{kij}$	Δ in exports of country 'k' of product 'i' to country 'j' due to interaction of structural effect and competitive effect.
Total		ΔQ_{kij}	Δ in value of exports of country 'k' to destination 'j' of product 'i'.

Worked out example

By making use of the CMS analysis, here we are analyzing the growth rate of export value of Thailand's Catfish in the United States over the period 1987-2008. The decomposition is carried out in Table 2.

Table 2: Decomposition of Growth rate of Export Value of Thailand's Catfish in the United States

Main component	Sub-component	1993-1996 Over 1989-1992	1997-2000 Over 1993-1996	2001-2004 Over 1997-2000	2005-2008 Over 2001-2004
Structural effect (% change in export value)		29	165	282	3
	Growth effect (% to structural effect)	-2702527	2803929	1398337	435800
	Market effect (% to structural effect)	835	146	-2588	-2242
	Commodity effect (% to structural effect)	401585	-3882886	-605063	-99436
	Structural interaction effect (% to structural effect)	2300207	1078911	-790586	-334021
Competitive effect (% to change in export value)		93	-41	-72	12
	General competitive effect (% to competitive effect)	-481853	5879165	6364692	-9387
	Specific competitive effect (% to competitive effect)	481953	-5879065	-6364592	9487
Second order effect (%change in export value)		-22	-24	-109	85
	Pure second order effect (% to second order effect)	33	10	17	41
	Dynamic structural residuals (% to second order effect)	67	90	83	59
Change in export value %		100	100	100	100
Absolute change in export value ('000 $)		-109	9	18	14073

Interpretation of results

The growth effect and the specific competitive effect indicate an increase in market share of Thailand's Catfish in the United States America (US.) market and thus a substantial growth is recorded in the catfish exports of Thailand. A comparison of the export details of similar products of other major countries to the U.S., using the same technique, could give a clear picture of the more competitiveness enjoyed by Thailand.

Price spread analysis

1. **Definition**

Marketing is the performance of business activities that direct the flow of goods and services from producer to consumer or user. Marketing is the social process by which individuals and groups obtain what they need and want through creating and exchanging products and value with others.

2. **Theoretical back ground**

Marketing Functions:

Any single activity performed in carrying a product from the point of its production to the ultimate consumer may be termed as a marketing function. It may have anyone or combination of three dimensions, viz., time, space and form.

E.g.- The marketing of fish may involve carrying, price determination, selling, buying, grading, processing, packing, storage, etc.

Marketing Channels:

Marketing channels are routes consisting of intermediaries through which commodities move from producers to consumers.

E.g. - Fish marketing channels -

(i) Fisherman - Auctioneer - Retailer - Consumer
(ii) Fisherman - Auctioneer - Processor - Wholesaler - Retailer – Consumer
(iii) Fishermen- Auctioneer- Commission agents-Processor(Fish meal plants)-Exporter
(iv)Fishermen- Local traders- Retailers- Consumers
(v) Fishermen-Local traders- Wholesalers- Commission agents- Retailers- consumers
(vi) Fishermen- Assemblers- Wholesalers-- Exports

Price Spread:

The difference between the price paid by consumer and the price received by the producer for an equivalent quantity of product is known as price spread. Marketing system is efficient when price spread is minimum. The price spread includes –

(i) Marketing Cost (MC): The costs or expenses incurred in moving the product or service from producers to consumers.
E.g. - Transportation, packing, processing, etc.

(ii) Marketing Margin (MM): Profits or income earned by various market intermediaries involved in moving the produce from the production to the ultimate consumption.
E.g. - Commission, retailer's profit, etc.
So, Price Spread(PS) = Consumer's Price (CP) - Producer's Price (PP)
= Marketing Cost + Marketing Margin.

3. **Practical utility**

- Countries can appropriate added value from fish by expert marketing.
- Consumers are mainly benefitted due to improved marketing such as they get fresh fish at lower prices
- Producers gets benefitted as if their profits rise as a result of greater prices - attained from improvements in quality, or lower costs following from improvements in productivity.
- Analysis of market structure would enhance the efficiency of fish marketing system and offer valuable information for developing policy framework.
- Price spread analysis help to find the share of fishermen in the consumer's rupee.
- Analysis of price at the landing centers and in retail markets would help to measure the efficiency of the marketing system

4. **Keywords**

Marketing, Price, Marketing functions and Marketing cost

5. **Software support**

Ms. Excel

6. **Data requirements**

Data on the total quantity and species of fish, transportation cost, price of fish sold to the consumers, auction rate and retailers price was collected.

7. **Methodology**

The methodology adopted for determining the efficiency of the marketing system

Step 1: Quantifying the marketing cost
Step II: Quantifying the marketing margin
Step III: Estimation of the price spread
Step IV: Estimation of the efficiency of the marketing system

Price spread

Price spread or Gross Marketing Margin(GMM) is the difference between the net price received by the fishermen at landing centre (Price at first sales) and price paid by the consumer (Retail price or Price at last sales) for any given commodity at a particular point of time in a market.

Marketing Cost (MC):

The costs or expenses incurred in moving the product or service from producers to consumers.

E.g. - Transportation, packing, processing, etc.

Marketing Margin (MM):

Profits or income earned by various market intermediaries involved in moving the produce from the production to the ultimate consumption.

E.g. - Commission, retailer's profit, etc.

Price Spread = Consumer's Price (CP) - Producer's Price (PP)

= Marketing Cost + Marketing Margin.

Efficiency of the marketing system

An efficient marketing system is the one, where the primary producer gets maximum benefit. In an efficient marketing system, the marketing cost will be at minimum. The efficiency of the marketing is assessed by working out the following indicators.

Fishermen's share in the consumer's rupee and Gross Marketing Margin (GMM) were used for analysing the trends in landings and studying the price behaviour.

1. *Gross Marketing Margin (GMM)*
   GMM=RP-LP
   RP is Retail Price, LP is Landing centre Price
   Where Landing centre Price (LP) is the net price received by the fishermen at landing centre (first sales) after deducting the auction charges and RP is the price paid by the consumer

2. *Percentage Share of Fishermen in the Consumer's Rupees (PSFCR)*
   PSFCR = (LP/RP)*100

3. *Percentage Share of Marketing Margin in Consumer's Rupee (PMMCR)*
   PMMCR = (1-LP/RP)*100
   Where RP = retail centre price
   LP = landing centre price

8. **Worked out example:**

Case I:

A fisherman, Mr. Moosa comes to Alapuzha Fish Landing Centre, with 100 kg of Sardine fish. The transportation charges to bring the fishes to the landing centre are @ Re. 0.70/kg. He takes the fishes to an auctioneer, Mr. Ravi and the fishes are auctioned and one wholesaler Mr. Koya purchases the lot @ Rs. 50/kg. Mr. Ravi takes auction rate @ Rs.0.35/kg from Mr. Moosa. Mr. Koya brings the fishes to palayam market with transportation cost @ Re.0.85/kg and sells the lot to a retailer, Mr. Kumar @ Rs.55/kg. Mr. Kumar sells the fishes to consumers @ Rs.60/kg in the same market. It is assumed that there is no loss in transit and no significant time lag.

Case II:

A fisherman, Mr. Iqbal comes to Chaliyam Fish Landing Centre, with 100 kg of sardine fish. The transportation charges to bring the fishes to Chaliyam landing centre is @ Re. 0.60/kg. He takes the fishes to an auctioneer-cum-retailer, Mr. Maanu and sells the lot @ Rs.50/kg. Mr. Maanu then sells the fishes to consumers @ Rs.55/kg at ramanattukara market and he provides the transportation charges from chaliyam to ramanattukara market @ Re. 0.70/kg and icing charges @ Re. 0.50/kg.

Work out MC, MM, Price Spread, and Producer's share in consumer's rupee and interpret for both the cases.

9. **Computation technique**

Case - I:

(A) Transportation cost paid by Mr. Moosa, fisherman
= 100 x 0.70 = Rs.70.

(B) Transportation cost paid by Mr. Koya, wholesaler
= 100 x 0.85 = Rs.85
∴ Total Marketing Cost (MC) = A + B = 70 + 85 = Rs.155

(C) Commission taken by Mr. Ravi auctioneer from Mr. Moosa
= 100 x 0.35 = Rs.35.

(D) Profit earned by Mr. Koya
= 100 x {55 - (50+ 0.85)} = 100 (55 – 50.85)
= Rs.415.

(E) Profit earned by Mr. Iqbal, retailer

= 100 (60-55) = 100 x 5 = Rs.500.

∴ Total Marketing Margin (MM) = C + D + E = 35 + 415 + 500
= Rs. 950

∴ Price Spread for 100 kg Sardine here
= MC + MM
= 155 + 950 = Rs.1,105.

∴ Total price received by Mr. Moosa, fisherman
= (100 x 50) - (70 + 35) = 5000 - 105
= Rs.4,895

∴ Total price paid by the consumers = 100 x 60 = Rs.6,000

∴ Producer's share in consumer's rupee

$$= \frac{4895}{6000} \times 100 = 81.5 \text{ percent}$$

Case II:

(A) Transportation cost paid by Mr. Iqbal, fisherman
= 100 x 0.60 = Rs.60

(B) Transportation cost paid by Mr. Maanu auctioneer-cum-retailer
= 100 x 0.70 = Rs.70

(C) Costs for icing paid by Mr. Maanu
= 100 x 0.50 = Rs.50

∴ Total Marketing Costs (MC)
= A + B + C
= 60 + 70 + 50
= Rs.180

Profit earned by Mr. Maanu
= 100 {55 -(50 + 0.70 + 0.50)}
= 100 (55-51.2)
= Rs.380

∴ Total Marketing Margin (MM) = Rs.380

∴ Price spread for 100 kg sardine
= MC + MM
= 180 + 380
= Rs.560

∴ Total price received by Mr. Iqbal, fisherman
= (100 x 50) - 60
= 5000-60
= Rs.4,940

∴ Total price paid by the consumers
= 100 x 55
= Rs.5,500

∴ Producer's share in consumer's rupee = $\frac{4940}{5500} \times 100 = 89.8$ percent

Case 1	
Name of fish	Sardine
Marketing cost (MC)	155
Marketing margin (MM)	950
Price spread	1105
Producers share	81.5
Percentage Share of Marketing Margin in Consumer's Rupee	18.5
GMM	1105
Case 2	
Name of fish	Sardine
Marketing cost (MC)	180
Marketing margin (MM)	380
Price spread	560
Producers share	89.8
Percentage Share of Marketing Margin in Consumer's Rupee	11
GMM	560

10. Interpretation of results

Marketing system in Case-II is more efficient than that of Case-I, because price spread is less in Case-II than Case-I. The producer's share in consumers rupee is more in Case-II than that of Case-I. These are because of less number of intermediaries involved in Case-II than Case-I. So, the marketing efficiency will be more where the intermediaries are minimum in the marketing system.

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5

PRICE INDEX NUMBER AND ITS APPLICATION IN FISH PRICE ASSESSMENT

Shyam S. Salim and Athira N. R.

Definition

Index Numbers:

Index numbers are devices for measuring differences in the magnitude of a group of related variables. It is a device to measure change. Changes are measured from time to time or place to place.

E.g. Group of variables at different points of time or location.

Price index number:

A price index number for a commodity or group of commodities is the price of the commodity at a particular time expressed as a percentage.

Practical Utility

Price index numbers are extensively used for a variety of purposes in economics, business management, consumption patterns, personnel and financial matters etc. In the fisheries sector rice index numbers provides an insight on assessing the price behavior and trend in fish production over the years. It is also constructed to track the profitability change in fisheries.To a fishery, index number is applied before and after catch shares are applied which results in analyzing profits improved after implementation of catch shares. They act as economic barometers and measures the changes and behavior of the fishery economy. Index numbers also provide the guidelines for formulating policies and arriving at decisions based on the measured change.

Key words

Simple index number, Laspeyre's Method, Passche's Method, Marshall Edgeworth Method

Software Support

The data can be tabulated in MS-excel. However, it may also be computed in software such as R, SPSS etc.

Data requirement

Quantity of different species fish traded across the different markets over the years of a particular place with its price at the specified period of time. Moreover the prices received for catch, prices paid for inputs, fishery stock biomass and vessel productivity over the years are also required for constructing price index numbers at different levels.

Methodology:

The methodology adopted for the arriving at the price index number of a particular commodity (eg. fish) across the different periods involves the following steps.

1. Definition of the purpose and scope.
2. Selection of species of fish to be included

3. Collection of prices of fish
4. Selection of the base period
5. Choice of average to be used
6. Selection of suitable weights

Simple index number:

$$I_t = \frac{P_t}{P_o} \times 100$$, where

I_t = Simple index

P_t = Price in period t

P_o = Price in the base period

(i) Laspeyre's Method:

$$I_t = \frac{\sum_{i=1}^{n} P_{it} Q_{it}}{\sum_{i=1}^{n} P_{i0} Q_{i0}} \times 100 \text{ or } \frac{\sum\left(\frac{P_{it}}{P_{i0}}\right) P_{i0} Q_{i0}}{\sum P_{i0} Q_{i0}} \times 100$$, where

I_t = Aggregative price index for period t

$P_{it} P_{io}$ = Prices of i[th]fish species in t[th] base period.

Q_{io} = Quantity of i[th]fish species in base period

(ii) **Passche's Method:**

$$I_t = \frac{\sum P_{it} Q_{i0}}{\sum P_{it} Q_{it}} \times 100 \quad \text{Or} \quad \frac{\sum\left(\frac{P_{it}}{P_{io}}\right) P_{it} Q_{i0}}{\sum P_{i0} Q_{i0}}$$, where

I_t = Aggregative price index for period t

$P_{it} P_{io}$ = Prices of i[th] fish species in t[th] on the base period

Q_{it} = Quantity of i[th]fish species in i[th] period.

(iii) **Marshall, Edgeworth Method:**

$$I_t = \left\{ \frac{\sum_{i=1}^{n} P_{it(Q_{it} + Q_{i0})}}{\sum_{i=1}^{n} P_{i0(Q_{it} + Q_{i0})}} \times 100 \right\}$$

I_t = Aggregative price index for period t

$P_{it} P_{io}$= Prices of i[th] fish species in t[th] on the base period

Q_{it} = Quantity of i[th]fish species in i[th] period.

(vi) Fisher's Method:

Fisher Index Number = $\sqrt{\text{Laspeyre's index for year t} \times \text{Passche's index for year t}}$

Worked out example

Given below are the tables representing the landing centre price from 2010 to 2015 and the quantity of production of the different species during the years 2010 and 2015 of the different selected varieties of fish species in Kerala. The calculation of the different index numbers with 2010 as the base year and their inferences are given below.

Table1.Landing Centre Prices (LCP) of different species of fish in Kerala.

Sl.No		2010	2011	2012	2013	2014	2015
		Landing Centre Price (LCP)					
1.	Sharks	107	275	280	360	420	380
2.	Rays	46	55	60	85	90	135
3.	Oil Sardine	34	18	19	28	45	65
4.	Lizard fishes	24	52	60	140	195	290
5.	Threadfin Breams	33	40	45	130	115	145
6.	Croakers	50	55	60	65	85	155
7.	Ribbon Fish	39	65	70	102	135	170
8	Mackerels	52	54	55	80	95	120
9.	Billfishes	40	85	90	180	230	410
10.	Penaeid prawns	320	85	110	196	220	295

Table2. Total production of the selected varieties of fish in Kerala during 2010-11 and 2015-16

Quantity			
Sl.No	**Species**	**2010-11**	**2015-16**
1.	Sharks	2014	3481
2.	Rays	926	2891
3.	Oil Sardine	259341	68431
4.	Lizard fishes	7658	12395
5.	Threadfin Breams	33421	42253
6.	Croakers	4090	4432
7.	Ribbon Fish	9674	12253
8	Mackerels	68494	70079
9.	Billfishes	2339	5314
10.	Penaeid prawns	35624	38006

Solution:

I. Computation of landing centre price index of the selected species

The domestic price behavior can be understood with the help of index numbers.The simple index numbers for the landing centre prices were constructed to compare the price across the years and are indicated in the given table 3. The landing centre price indices were worked out for the selected varieties for the years 2011, 2012,2013,2014,2015 with 2010 as the base year (year 2010 = 100). It has been found that during the period from 2011 to 2015, sharks (83.48 per cent), oil sardine (61.18 per cent) and penaeid prawns (72.19 per cent) recorded the highest increase in prices at landing centre level.

Table 3: Index numbers of landing centre prices of selected varieties of fish in Kerala

Sl. No.	Species	2011	2012	2013	2014	2015
		LCP Index numbers				
1.	Sharks	157.01	161.68	136.45	192.52	155.14
2.	Rays	119.57	130.43	174.78	175.65	183.48
3.	Oil Sardine	102.94	155.88	182.35	132.35	161.18
4.	Lizard fishes	216.67	150.00	183.33	112.50	108.33
5.	Threadfin Breams	121.21	136.36	193.94	148.48	139.39
6.	Croakers	110.00	120.00	130.00	170.00	109.40
7.	Ribbon Fish	166.67	179.49	161.54	146.15	135.90
8	Mackerels	103.85	105.77	153.85	182.69	130.77
9.	Billfishes	112.50	125.00	150.00	175.00	125.00
10.	Penaeid prawns	126.56	134.38	161.25	168.75	172.19

2. Computation of different index numbers

The different index numbers such as Laspeyre's index, Passche's index, Marshall Edgeworth and fisher index have been calculated using the quantity and price of the different selected fish species. The calculations and the intermediate steps have been indicated in the following table 4.

Laspeyre's index $= \frac{46779013}{25999087} \times 100$

$= 179.92$

Passche's index $= \frac{40451120}{21242137} \times 100$

$= 190.42$

Marshall Edgeworth index $= \frac{87230133}{47241224} \times 100$

$= 184.64$

Fisher Index $= \sqrt{179.92 \times 190.42}$

$=185.10$

Generally index numbers are constructed based on the data available for calculation. Different index numbers differ based on the dataset used. Among all the index numbers constructed it can be inferred that fisher index number is the best index number because it includes both current and past year's quantity as the base of price index where Laspeyre's index use base period quantity and Passche's index use the current period quantity as the base of the price index.

Table 4. Calculation of different price index numbers

Species	Price		Production in base period 2010-11	Production in 2015-16	Laspeyre's Value of production 2010 -11 at prices		Laspeyre's Price relative of 2015-16 weighted by 2010-11 value	Passche's Value of production 2010 -11 at prices		Passche'sPrice relative of 2015-16 weighted by 2010-11 value	Marshall Edgeworth Value of production 2010 -11 at prices		Marshall Edgeworth Price relative of 2015-16 weighted by 2010-11 value
	2010-11	2015-16			2010-11	2015-16		2010-11	2015-16		2010-11	2015-16	
Sharks	107	380	2014	3481	215498	765320	765320	372487	1322850	1322850	587985	2088170	2088170
Rays	46	135	926	2891	42596	125010	125010	132975	390254	390254	175571	515263.5	515264
Oil Sardine	34	65	259341	68431	8817594	16857165	16857165	2326660	4448027	4448027	11144254	21305192	21305192
Lizard fishes	24	290	7658	12395	183792	2220820	2220820	297473	3594462	3594462	481265	5815282	5815282
Threadfin Breams	33	145	33421	42253	1102893	4846045	4846045	1394347	6126678	6126678	2497240	10972723	10972723
Croakers	50	154.7	4090	4432	204500	632723	632723	221611	685664.4	685664	426111	1318387	1318387
Ribbon Fish	39	170	9674	12253	377286	1644580	1644580	477871	2083028	2083028	855157	3727608	3727608
Mackerels	52	120	68494	70079	3561688	8219280	8219280	3644132	8409535	8409535	7205820	16628815	16628815
Billfishes	40	410	2339	5314	93560	958990	958990	212562	2178762	2178762	306122	3137752	3137752
Penaeid prawns	320	295	35624	38006	11399680	10509080	10509080	12162018	11211860	11211860	23561698	21720940	21720940
Total					25999087		46779013	21242137		40451121	47241224		87230133

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6

MEASUREMENT OF INSTABILITY IN FISHERIES

S.S. Raju

Concept

The measure that is used to estimate instability in a variable over time should satisfy two minimum properties. It should not include deviations in the data series that arise due to secular trend or growth. Two, it should be comparable across data sets having different means.

One way to exclude variations in a data series due to the trend, is, to fit a suitable trend (for example $Y_t = a + bT + e_t$; where Y is dependent variable like prices or production, T refers to time, a is intercept and b is slope) and de-trend the series. This is done by computing residuals [e_t = Y- (a + bT)], i. e. deviations between actual and estimated trend values, and estimating instability based on e_t. As mean of e_t is always zero, their standard deviation is used to measure instability. The main problem with this is comparability across data sets having different mean values. This necessitates use of Coefficient of Variation (CV), instead of standard deviation (SD), to measure dispersion. As "mean" of detrended residuals is zero, it is not possible to compute CV of residuals (e_t), however, researchers have developed some methods to compute CV that is based on residuals. Mehra (1981) used standard deviation in residuals divided by mean of the variable (Area, production or yield) to compute and compare instability in agricultural production before and after introduction of new technology. The author termed the estimate as coefficient of variation even though it does not follow standardized definition of CV. Hazell (1982) developed a new method to make use of residuals to estimate instability, which was slightly different than the measure developed by Mehra (1981). Hazell detrended the data and constructed a variable (Z_t) which was computed by adding mean of the dependent variable to residuals e_t as under: $Z_t = e_t + Y$. Coefficient of variation of Z_t was used as a measure of instability. The measures of instability proposed by Mehra (1981) and Hazell (1982) are based on detrended data, they are unit free and imparts comparability. However, these methodologies have been criticized for measuring instability around an arbitrarily assumed trend line which greatly influences inference regarding changes in instability (Ray, 1983a).

Ray (1983b) developed a very simple measure of instability given by standard deviation in annual growth rates. The method satisfies the properties like instability based on detrended data and comparability. Moreover, the methodology does not involve actual estimation of trend, computation of residuals and detrending, but all these are taken care in the standard deviation of annual growth rate. This method also does not suffer from the limitations like arbitrary choice of assumed trend line initially proposed and used by Hazell (1982) and subsequently applied by Larson *et al.,* (2004) and Sharma *et al.,* (2006).

Effect of Choice of Period on Instability

It is pertinent to point out that the selection or length of period can result in significant changes in instability particularly if two sub periods with different dimensions of instability or pooled into one. This is demonstrated in Table 1 for food grains at all India level. The table presents estimates of instability (C.V.) derived from detrended yield, detrended production and production taken as product of the detrended area and detrended yield, as used by Hazell (1982), Larson *et al.,* (2004) and Sharma *et al.,* (2006).

Instability in food grain yield measured by the CV in detrended yield was 4.50 in pre green revolution period (same as reported by Larson *et al.,* 2004) and, it increased to 5.06 in the post green revolution period that covers the period 1968 to 1988. Variability in yield dropped to 3.72 after 1989 indicating a decline of 26.5

per cent in the second phase of green revolution as compared to the first phase and a decline of 17.3 per cent compared to pre green revolution period. If both these sub periods are pooled then instability in yield turns out to be 5.50 which is 22.2 per cent higher than the pre green revolution period. These differences lead to totally different types of inference about effect of improved technology on instability in food grain productivity. According to pooled data for post green revolution (1968 to 2007) spread of new technology was accompanied by an increase in yield variability, whereas, dividing post green revolution period into two sub period shows increase in variability in the initial years of adoption of new technology and a sharp decline with spread of new technology after 1988. Another conclusion that follows from these results is that there could be a complete change in the effect of factors like new technology between short and long term.

Table 1: Coefficient of variation (%) in detrended yield and production of food grains in India during different periods

Period	Production	Production = Detrended A * detrended Y	Yield
1951-65	6.11	5.73	4.50
1968-88	6.32	6.43	5.06
1989-07	4.94	5.02	3.72
1968-02	5.47	5.51	5.30
1968-07	6.30	6.52	5.50

Source: Agricultural Statistics at a Glance 2008, Ministry of Agriculture, GOI, New Delhi

Almost similar pattern is observed in the case of production of food grains whether we use data on detrended production or we use detrended production data obtained by multiplying detrended area and detrended yield. Instability in food grain production during 1951 to 1965 was 6.11 (same as reported by Larson *et al.,* 2004), and it increased with the introduction of new technology in India. Food grain production show much higher fluctuations in post green revolution period compared to pre green revolution period when no distinction is made between different sub periods. When a distinction is drawn by splitting post green revolution period into sub periods the conclusion on effect of new technology on production variability changes altogether (Table 1). This formed the basis for us to examine instability in agricultural production by dividing the period after introduction of new technology into two phases.

This paper preferred to use the method proposed by Ray (1983b) and applied by Ray (1983a), Mahendradev (1987) and Rao *et al.,* (1988) to estimate instability in agricultural production. This method is given by:

Instability index = Standard deviation of natural logarithm (Y_{t+1}/ Y_t)

where, Y_{t+1} is for the current year/month and, Y_t is the production / price in the previous year/month. This index is unit free and very robust, and it measures deviations from the underlying trend (log linear in this case). When there are no deviations from trend, the ratio of Y_{t+1}/ Y_t is constant and thus standard deviation is zero. As the series fluctuates more, the ratio of Y_{t+1} and Y_t also fluctuates more, and standard deviation increases (Chand and Raju, 2008; 2009, Chand *et al.,* 2011 and Raju *et al.,* 2014).

Example:

Tuna Price Instability in Andhra Pradesh – A case study

Instability in month wise average prices of tuna experienced at Lawson Bay landing centre, Visakhapatnam district of Andhra Pradesh during 36 months before and after November, 2014 has been presented in Table 2. Instability index for prices has shown decrease after November 2014. It decreased from 13.08 per cent to 4.39 per cent in tuna (Table 2).

Table 2: Month wise average Prices of tuna and its instability at Lawson Bay landing centre, Visakhapatnam district of Andhra Pradesh

S.No.	Year	Month	Tuna Price(Rs/kg)	ln of growth
1.	2013	June	123	-
2.	2013	July	105	-0.15822
3.	2013	August	96	-0.08961
4.	2013	September	103	0.070381
5.	2013	October	99	-0.03961
6.	2013	November	115	0.149812
7.	2013	December	120	0.04256
8.	2014	January	125	0.040822
9.	2014	February	140	0.113329
10.	2014	March	138	-0.01439
11.	2014	April	138	0
12.	2014	May	143	0.035591
13.	2014	June	103	-0.32812
14.	2014	July	134	0.263111
15.	2014	August	136	0.014815
16.	2014	September	124	-0.09237
17.	2014	October	135	0.084993
18.	2014	November	130	-0.03774
19.	2014	December	130	0
20.	2015	January	133	0.022815
21.	2015	February	132	-0.00755
22.	2015	March	128	-0.03077
23.	2015	April	140	0.089612
24.	2015	May	143	0.021202
25.	2015	June	135	-0.05757
26.	2015	July	137	0.014706
27.	2015	August	135	-0.01471
28.	2015	September	140	0.036368
29.	2015	October	131	-0.06645
30.	2015	November	138	0.052056
31.	2015	December	137	-0.00727
32.	2016	January	138	0.007273
33.	2016	February	137	-0.00727
34.	2016	March	138	0.007273
35.	2016	April	148	0.069959
36.	2016	May	137	-0.07723
Instability (Period I)	SD of Jun 13 to Nov 14			0.130847
Instability (Period II)	SD of Nov 14 to May 16			0.043895

Steps involved in the Instability calculation:

Step 1: Calculate natural logarithm of growth between current and previous month

Step 2: Calculate the Standard Deviation (SD) of the selected period eg : June 2103 to November 2014

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7

COINTEGRATION TECHNIQUE TO DETERMINE MARKET PRICE INTEGRATION: APPLICATIONS IN FISHERY SECTOR

Shinoj Parappurathu

Introduction

Stationarity is an important pre-requisite for time-series variables to possess and to be used effectively for drawing standard statistical/economic inferences involving them. A time-series is considered to be stationary if it possesses constant unconditional mean and variance over time. Such series perpetually return to their long-run equilibrium mean and variance in spite of temporary fluctuations. In economic literature, the implications of drawing economic inferences based on analysis involving non-stationary variables were more or less ignored for a long time. The irrationality of running spurious regressions with non-stationary time series and drawing important conclusions based on such analysis came to light with the publication of seminal papers by Granger and Newbold (1972) and Nelson and Plosser (1982). Thereafter, diagnostic checks for stationarity have emerged as an important norm before proceeding to any econometric analysis involving time-series variables. In addition, transforming non-stationary variables to stationary ones by successive differencing was mooted as a solution to the problem of non-stationarity. However, several statisticians through their subsequent works questioned the logic of using only the differenced series in economic models as it can potentially cause misspecification errors. Granger (1981) based on empirical examples suggested that a vector of non-stationary variables could have linear combinations which are stationary at levels. Subsequently, Engle and Granger (1987) showed that integrated variables having long-run equilibrium relation with each other can be identified by testing whether the residuals from a regression involving the original variables are stationary or not. This property of time series variables was denoted by the term ‘cointegration’ and turned out to be a corner stone in subsequent deliberations on the subject. Cointegration analysis, since then is used widely in the economic literature for defining relationships between wide variety of economic variables under varying economic contexts.

Cointegration: Methodological Framework

Let $Y_t = (y_{1t},...,y_{nt})'$ denote an (n×1) vector of I (1) time series. Y_t is cointegrated if there exists an (n×1) vector $\beta = (\beta_1,...,\beta_n)'$ such that,

$$\beta_0 Y_t = \beta_1 Y_{1t} + \cdots + \beta_n Y_{nt} \sim I(0)$$ …….. (1)

In words, the non-stationary time series in Y_t are cointegrated if there is a linear combination of them that is stationary or I (0).

For the sake of simplicity, the above relationship is explained considering the cointegrating relationship of only two variables, i.e., Y_t and X_t hereafter. Two times-series variables are said to be integrated if there exists a long-term equilibrium relationship between them and the degree of their long-run association can be obtained by fitting a classical regression model given by equation (2):

$$Y_t = \beta_0 + \beta_1 X_t + e_t$$

where,

Y_t = Dependent variable
X_t = Independent variable
β_0=Constant
β_1=Long-run elasticity, and
e_t= Error-term.

However, assumptions of the classical regression model necessitate that both Y_t and X_t variables should be stationary and the errors should have a zero mean and finite variance. A stationery series is one whose parameters (mean, variance and autocorrelations) are independent of time. As mentioned above, regression between two non-stationary variables may result in spurious relationship with high R^2 and t-statistics that appear to be significant, but with the results of having no economic meaning. Under such circumstances, the series have to be first checked for stationarity. If a time series requires first order differencing to be stationary, then it is said to be I (1) which means integrated of order one. I (2) series requires differencing twice to become stationary and so on. If it is verified that both the series are stationary, then the classical regression model [equation (1)] would hold good and the β coefficient would represent the coefficient of price transmission. However, if the two series prove to be non-stationary but integrated of the same order, the validity of regression can be checked by testing the residuals of the regression for stationarity. As demonstrated by Engle and Granger (1987), if the residuals from such a regression turn out to be stationary, then the series are co-integrated and there existed a long-run relationship between the two series. Engle-Granger theorem states that if a set of variables are co-integrated of order (1, 1), then there exists a valid error-correction representation of the data. Converse of this theorem also holds good, that is, if an error correction model (ECM) provides an adequate representation of the variables, then they must be co-integrated. However, if the series are integrated of different orders, the regression equations using such variables would be meaningless and it can be concluded that there cannot exist any long-term relationship between the two.

The stationarity of a series can be tested using a unit root test, the most widely used being Augmented Dickey-Fuller(ADF) unit root test. It would test the null hypothesis that the series has a unit root, i.e. non-stationary.

The test is applied by running the regression of the form given in Equation (3):

$$Y_t = \beta_1 + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t$$

where, e_t is a pure white noise error-term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$.

Once it is established that the order of integration is the same for the variables of interest, the second stage of testing co-integration can be undertaken. The co-integrating equation is the same as Equation (1). The error-term arising from this regression is then subjected to testing of stationarity. The ADF test in this context is known as Augmented Engle-Granger test whose critical values were provided by Engle and Granger (1987). Davidson and Mackinnon (1993) have revised these values and in the present study, these values have been used. The stationarity in the error-term confirms co-integration between the series and the existence of long-term equilibrium. However, there can be short term disequilibrium which means that a change in series is not immediately passed on to the other. Using the Error Correction Model (ECM), the speed of adjustment towards the long-run path can be ascertained and the model is represented by Equation (4):

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 e_{t-1} + \varepsilon_t$$

where, e_{t-1} is the lagged error-term of the co-integrating regression and ε_t is the disturbance- term. The magnitude of α_2 explains the speed at which the series approaches equilibrium and it is expected to be negative, so that the equilibrium is restored in the long-run.

Application in Fishery Sector: An Example

In the fish marketing system, price movements in different markets depend to a large extent on the cross market movement of available catch, which in turn, is governed by the demand and supply factors. The extent of price transmission from one market to the other and its direction are the important aspects to be looked into, as these would provide valuable information on the degree of integration, and in turn, the efficiency of these markets (Shinoj *et al*, 2008). In this paper, the degree of spatial market integration between two coastal fish markets in India, i.e., Visakhapatnam and Chennai has been studied by applying cointegration analysis based on monthly retail price data[1] on important fish species. The data used pertains to the period 1998 to 2012.

As a first step to determine the price transmission mechanism between the markets for the fish species considered, an augmented Dickey-Fuller (ADF) unit root test was applied to ascertain the stationarity of the monthly price series. The results of this exercise are presented in Table 1.

Table 1. Augmented Dickey-Fuller unit root test on domestic retail market prices of sardine

Market	Commodity price series (in log)	Level	First difference	Level of integration
Vishakhapatnam	Sardine	-3.641**	-9.220***	I (1)
Vishakhapatnam	Mackeral	-3.820**	-8.903***	I (1)
Vishakhapatnam	Seerfish	-4.104***	-9.150***	I (1)
Vishakhapatnam	Pomfret	-2.815ns	-9.217***	I (1)
Vishakhapatnam	Tuna	-4.487***	-9.588***	I (1)
Vishakhapatnam	Shrimp	-2.231ns	-6.848***	I (0)
Chennai	Sardine	-3.165 ns	-8.718***	I (0)
Chennai	Mackeral	-4.914***	-8.520***	I (0)
Chennai	Seerfish	-3.760**	-8.570***	I (0)
Chennai	Pomfret	-3.314ns	-8.049***	I (1)
Chennai	Tuna	-6.214***	-9.882***	I (1)
Chennai	Shrimp	-3.324 ns	-7.766***	I (0)

Notes: *** and ** denote significance at 1per cent and 5 per cent levels respectively;

McKinnon critical values of ADF statistic under the assumption of both constant and time trends in the series are -4.015 (1 per cent) and -3.440 (5 per cent); Unit root test assumes both constant and time trends.

The price series corresponding to shrimp in Visakhapatnam and sardine, mackerel, seerfish, and shrimp in Chennai markets are proved to be stationary at level as well as at first difference as a consequence of the rejection of the null hypothesis that a unit root is present. In contrast, the prices of sardine, mackerel, seerfish, pomfret and tuna in Visakhapatnam and pomfret and tuna in Chennai markets became stationary only after the first differencing. The estimated ADF test statistics and their levels of significance corresponding to all the price series are presented in Table 1 for better clarity. The stationarity tests were performed under the assumption of the presence of time trends for the all the series considered.

[1]The price data used here are only indicative based on the broad market trends for the period considered. Therefore, the results presented may be taken only as hypothetical, meant for demonstration of the analytical procedure.

Table 2. Price integration between Vishakhapatnam and Chennai fish markets for major marine fish species

Fish species	Integrated/Not integrated	Elasticity of price transmission	Type of equilibrium	Lead market	Speed of adjustment
Sardine	Not Integrated	-	NA	NA	NA
Mackeral	Integrated	0.474^{***}	Long-run	VSP	NA
Seerfish	Integrated	0.544^{***}	Long-run	VSP	NA
Pomfret	Integrated	0.561^{***}	Short-run	CHN	-0.37^{***} (-4.124)
Tuna	Integrated	0.632^{***}	Long-run	VSP	NA
Shrimp	Not Integrated	-	NA	NA	NA

Notes: * and ** denote significance at 1 and 5 per cent levels respectively;
Figure within the parenthesis is Engle-Granger tau statistics for co-integration.

McKinnon critical values of ADF tau statistic are -3.48 (1 per cent) and -2.88 (5 per cent). NA denotes 'not applicable'.

The elasticity of price transmission for each of the fish species between the two markets were obtained by fitting regression models, as explained in methodology. Double log models were fitted so that the elasticities could be obtained directly from the estimated regression. A single step was required for all the combinations of stationary (at level) price series, but for other series, which were not stationary at level, a further two-step procedure was followed to ascertain the presence of co-integration. Table 2 presents a matrix with the price transmission coefficients for each of the market pair combinations. Besides this, the lead market[1] determining the flow of price signals between the market pairs, the type of equilibrium existing, and the speed of adjustment in case of short-run equilibrium are also presented in Table 2. It is clear that, the Visakhapatnam and Chennai markets are in long-run equilibrium in case of mackerel, seerfish and tuna, whereas they are not integrated at all in cases of sardine and shrimp. The estimated elasticity of price transmission shows relatively high level of flow of price signals between the market pairs in case of the fish species for which the markets are integrated. It is only in case of pomfret, that the market pair is cointegrated with short-run equilibrium with an error correction coefficient of -0.37 (significant at 1 % level). This coefficient indicates the speed of adjustment of the short- term fluctuations in prices towards the long term equilibrium. The fitted error correction model (ECM) for pomfret is depicted in Equation (5) presented below;

Error Correction Model for Visakhapatnam-Chennai market pair for pomfret:

$$\Delta \ln VSP = \underset{(0.001)}{0.002} + \underset{(-0.09)}{0.253^{***}} \Delta \ln CHN - \underset{(0.05)}{0.37^{***}} e_t\text{-}1$$

Conclusions

This chapter helps to develop a fair understanding on cointegration as an econometric tool to assess the level of price integration between fish market pairs. The empirical example depicted above demonstrates how econometric techniques are useful to model the behaviour of market prices over time and to unveil the complicated price transmission process taking place between markets. Such studies are important to identify the presence of supply-side constraints existing in markets, and in turn to devise appropriate strategies so as to bring about greater integration between them.

[2] The lead market was identified by comparing the Akaike information criteria (AIC) and Bayesian information criteria (BIC) of the alternative fitted models.

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8

MULTIDIMENSIONAL POVERTY INDEX (MPI) – A TOOL FOR ESTIMATING POVERTY

B. Johnson and C. Ramachandran

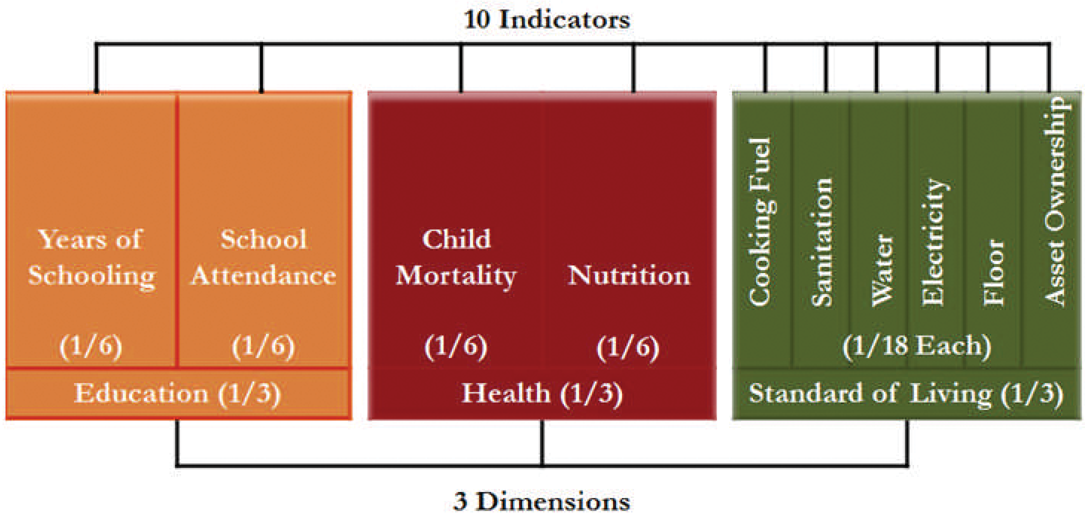
Concept

Poverty is the condition where people's basic needs for food, clothing, and shelter are not being met. Poverty is often defined by one-dimensional measures, such as income. The lives of people living in poverty are affected by more than just their income. But Multidimensional poverty is measured based on several factors like poor health, lack of education, inadequate living standard, lack of income, disempowerment, poor quality of work and threat from violence. The Multidimensional Poverty Index (MPI) reflects the deprivations that a poor person faces all at once with respect to education, health and living standard. A multidimensional measure can incorporate a range of indicators to capture the complexity of poverty and better inform policies to relieve it. Different indicators can be chosen appropriate to the society and situation. (Alkire & Maria, 2010)

The MPI gives a clear picture of people living in poverty, both across countries, regions and the world and within countries by urban/rural location, or other key household characteristics. It is the first international measure of its kind, and offers a valuable complement to income poverty measures because it measures deprivations directly. The MPI can be used as an analytical tool to identify the most vulnerable people, show aspects in which they are deprived and help to reveal the interconnections among deprivations. This enables policy makers to target resources and design policies more effectively (Alkire & Maria, 2010).

Utility

The MPI is an advanced analytical tool to measure poverty. It is essential for effective human development programs and policies by knowing the roots of poverty. MPI allows governments and other policymakers to understand the various sources of poverty for a region, population group, or nation and target their human development plans accordingly. The index can also be used to show shifts in the composition of poverty over time so that progress, or the lack of it, can be monitored (Alkire & Maria, 2010).



Indicators for Multidimensional Poverty Index along with their weightage

Computation Techniques

Poverty is measured using a methodology proposed by Alkire and Foster (2007, 2009) known as Multidimensional Poverty Index (MPI). MPI has three dimensions: health, education, and standard of living. These are measured using 10 indicators namely year of schooling, child enrollment, child mortality, nutrition, electricity, drinking water, sanitation, flooring, cooking fuel and assets.

1. **Education (each indicator is weighted equally at 1/6)**

- ❖ **Years of Schooling**: deprived if no household member has completed five years of schooling (16.66%).
- ❖ **Child Enrolment**: deprived if any school-aged child is not attending school in years 1 to 8 (16.66%).

2. **Health (each indicator is weighted equally at 1/6)**

- ❖ **Child Mortality**: deprived if any child has died in the family (16.66%).
- ❖ **Nutrition**: deprived if any adult or child for whom there is nutritional information is malnourished (16.66%).

3. Standard of Living (each indicator is weighted equally at 1/18)

- ❖ **Electricity**: deprived if the household has no electricity (5.55%).
- ❖ **Drinking water**: deprived if the household does not have access to clean drinking water or clean water is more than 30 minutes' walk from home (5.55%).
- ❖ **Sanitation**: deprived if inhabitants do not have an improved toilet or if their toilet is shared (5.55%).
- ❖ **Flooring**: deprived if the household has dirt, sand or dung floor (5.55%).
- ❖ **Cooking Fuel**: deprived if cooking is done with wood, charcoal or dung (5.55%).
- ❖ **Assets:** deprived if the household does not own more than one of: radio, TV, telephone, bike, or motorbike, and do not own a car or tractor. (5.55%).

A household is identified as multi-dimensionally poor if and only if it is deprived in some combination of indicators whose weighted sum exceeds 30% of all deprivations.

Output and interpretation of results

Procedure (Kindly refer Table 1)

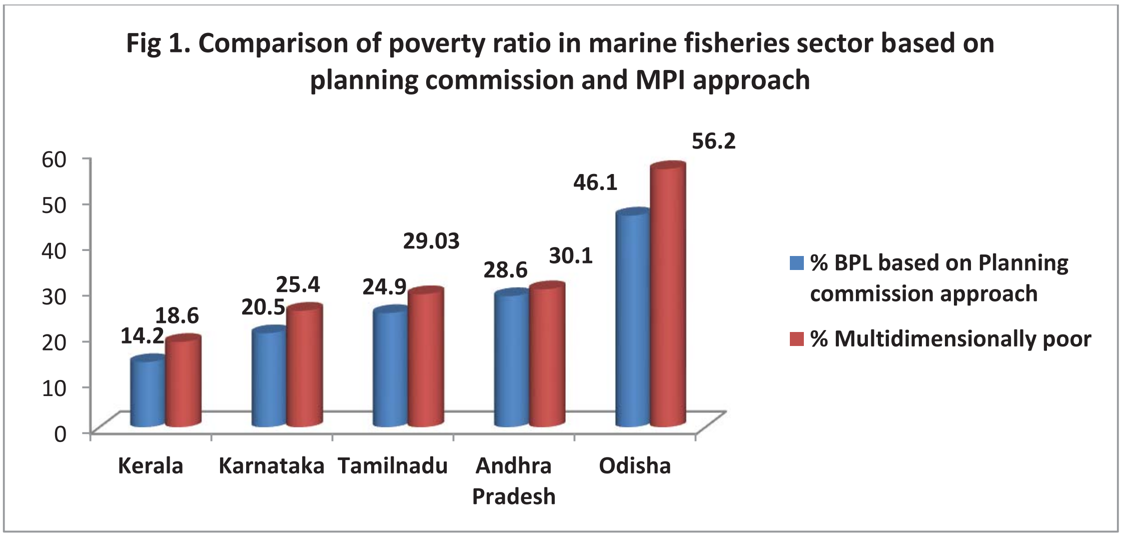
- ❖ Type the respondent name/household number in Column no. 1.
- ❖ Type the name of 10 indicators in the first row from Column no. 2-11.
- ❖ Row-wise, in each respondent, under each indicator enter only the deprived weightage value; if a family is not deprived in certain indicator, then enter the value as '0'.
- ❖ Similarly, enter the deprived weightage value under each respondent.
- ❖ Then Row-wise, add values from Column no. 2-11, which will give MPI value for that respondent/household and enter it in Column 12.
- ❖ The respondent/household having the weighted sum more than 30%, it is categorized under multi-dimensionally poor household.
- ❖ Finally by dividing the total no. of multi-dimensionally poor household with total no. of households, we will get the poverty ratio for the particular sample.
- ❖ In the example mentioned below, out of 30 sample household, 15 household are multi-dimensionally poor; hence the poverty ratio is 50 %.

Table 1: MPI computation

S.No	Respondent	Years of Schooling	Child Enrolment	Child Mortality	Nutrition	Electricity	Drinking water	Sanitation	Flooring	Cooking Fuel	Assets	MPI
	1	2	3	4	5	6	7	8	9	10	11	12
1	Robert	0	0	0	16.7	0	0	0	0	5.6	0	22.3
2	Mariya	0	0	16.7	16.7	0	0	0	0	5.6	5.6	**44.6**
3	Anthony Sami	0	0	0	16.7	0	5.6	0	0	0	5.6	27.9
4	Irudayaraj	0	0	0	16.7	0	0	0	0	5.6	5.6	27.9
5	Alonciyas	0	0	0	16.7	0	0	5.6	0	5.6	5.6	**33.5**
6	Arokiyadas	0	0	0	16.7	0	0	0	0	5.6	5.6	27.9
7	Arul Prakasam	0	0	16.7	16.7	0	0	5.6	0	0	5.6	**44.6**
8	Pusparaj	0	0	16.7	16.7	0	0	0	0	0	5.6	**39**
9	Jayaseelan	0	0	0	16.7	0	5.6	5.6	0	0	5.6	**33.5**
10	Sagayaraj	0	0	0	16.7	0	0	0	0	5.6	5.6	27.9
11	John Britto	0	0	0	16.7	5.6	5.6	5.6	0	5.6	5.6	**44.7**
12	Justin	0	0	0	16.7	0	0	5.6	5.6	5.6	5.6	**39.1**
13	Alex	0	0	0	16.7	5.6	0	5.6	0	5.6	5.6	**39.1**
14	Kristhuraj	0	0	0	0	0	5.6	5.6	0	5.6	5.6	22.4
15	Jackson	0	0	0	0	0	5.6	0	0	0	5.6	11.2
16	Muthu Raja	0	0	0	16.7	0	5.6	0	0	5.6	5.6	**33.5**
17	Alonce Mary	0	0	0	0	0	5.6	5.6	0	5.6	5.6	22.4
18	Vinanace	0	0	0	16.7	0	0	0	0	5.6	5.6	27.9
19	Francis	0	0	16.7	16.7	0	0	5.6	0	0	0	**39**
20	Mokkas	0	0	0	16.7	0	0	5.6	0	0	5.6	27.9
21	Jalastin	0	0	0	16.7	0	0	5.6	0	5.6	0	27.9
22	Hendry	0	0	0	16.7	0	5.6	0	0	0	5.6	27.9
23	Clement	0	0	0	16.7	0	0	5.6	0	5.6	5.6	**33.5**
24	Mocham	0	0	0	16.7	0	0	5.6	0	5.6	5.6	**33.5**
25	Jackson	0	0	0	16.7	0	0	5.6	0	5.6	5.6	**33.5**
26	Seelorias	0	0	0	16.7	0	0	0	0	5.6	0	22.3
27	Leninraj	0	0	0	16.7	0	0	5.6	0	0	0	22.3
28	Arokia Vinod	0	0	0	0	5.6	5.6	5.6	5.6	5.6	5.6	**33.6**
29	Kemlas	16.7	0	0	16.7	0	5.6	5.6	0	5.6	5.6	**55.8**
30	Raj	0	0	0	16.7	0	5.6	0	0	5.6	0	27.9

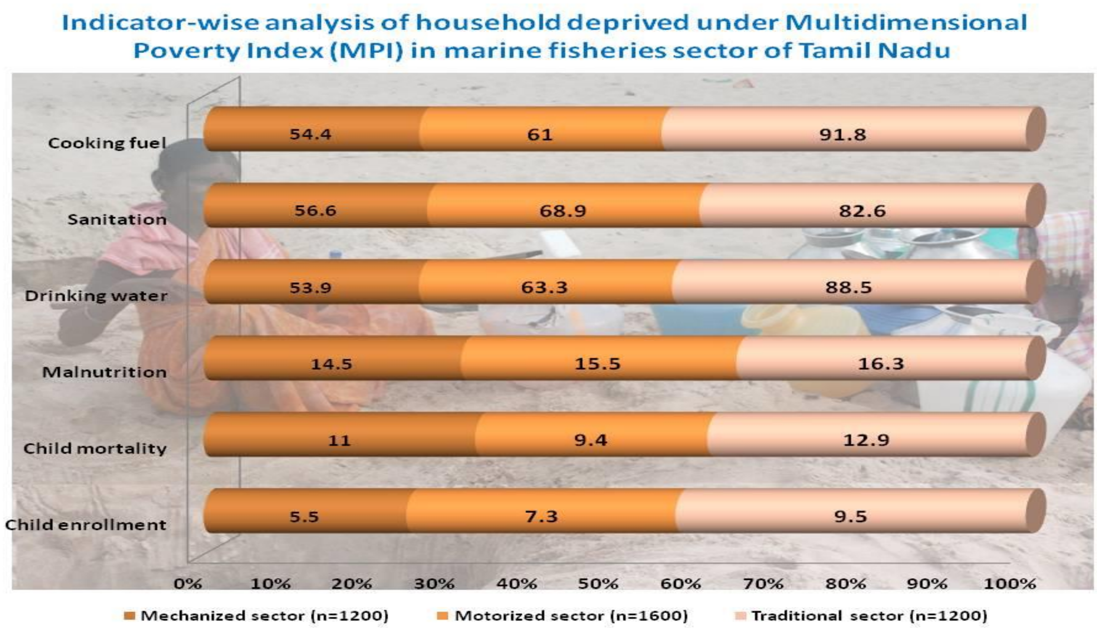
Under the project 'A diagnostic study on dimensions, causes, and ameliorative strategies of poverty and marginalization among the marine fisher folk of India' poverty ratio based on MPI approach and planning commission approach was studied for five states namely Kerala, Karnataka, Tamil Nadu, Odisha and Andhra Pradesh.

The study found that the multidimensional poverty ratio for Kerala, Karnataka, Tamil Nadu, Odisha and Andhra Pradesh through MPI approach was 18, 25, 29, 56 and 30 per cent respectively (Fig 1). It is important to note that the poverty ratio is high through MPI approach in comparison to planning commission approach in all the three states. The reason behind that was planning commission approach is based on one parameter expenditure/income, whereas the MPI approach in based on 10 indictors. Apart from income, a household may be deprived of other indicators, which may lead to increase in poverty ratio.



Indicator-wise MPI analysis in Tamil Nadu

Indictor-wise analysis of MPI in Tamil Nadu revealed that majority of the households is deprived of drinking or clean water and proper sanitation facilities. Use of wood, charcoal or dung for cooking was also found to be more. Very few cases of child mortality and malnutrition are reported in marine fisheries sector. School drop outs was also on the lower side (Fig 2).



Limitations of MPI (Rippin, 2010)

- Since the MPI simply counts the number of items lacked by households, it assumes that no correlation exists between them. This assumption is not realistic. It is rather safe to say that, for instance, proper sanitation and safe drinking water are related to health as well as educational indicators.
- The MPI is unable to capture inequality.
- The cut-off level of 30% is an arbitrary choice; changing it would affect poverty rates and even country rankings.

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9

FACTOR ANALYSIS: A TECHNIQUE FOR DATA REDUCTION

P.S. Swathi Lekshmi

Introduction:

The basic purpose of factor analysis is to summarize data so that relationship and patterns can be easily interpreted and understood. It is normally used to regroup variables into a limited set of clusters based on shared variance. Hence, it helps to isolate constructs and concepts. Factor analysis uses mathematical procedures for the simplification of interrelated measures to discover patterns in a set of variables (Child, 2006). Attempting to discover the simplest method of interpretation of observed data is known as parsimony, and this is essentially the aim of factor analysis (Harman, 1976).

Factor analysis has its origins in the early 1900's with Charles Spearmen's interest in human ability and his development of the Two-Factor theory; this eventually lead to a burgeoning of work on the theories and mathematical principles of factor analysis (Harman,1976). Factor analysis is used in many fields such as behavioural and social sciences, medicine, economics, and geography as a result of the technological advancements of computers.

Uses of Factor Analysis:

Factor analysis is useful for studies that involve a few or hundreds of variables, item from questionnaires or a battery of tests which can be reduced to a smaller set, to get at an underlying concept, and to facilitate interpretations. It is easier to focus on some key factor rather than having to consider too many variables that may be trivial, and so factor analysis is useful for placing variables into meaningful categories. Many other uses of factor analysis include data transformation, hypothesis-testing, mapping, and scaling (Rummel, 1970).

This technique is applicable when there is a systematic interdependence among a set of observed or manifest variable and the researcher is interested in finding out something more fundamental or latent which creates communality (commonness).

The recommended sample size is at least 300 participants and the variables that are subjected to factor analysis each should have at least 5 to 10 observations (Comery and Lee, 1992).

Factor Analysis- Methodology Framework

The theoretical basis for factor analysis is that variables are correlated because they share one or more common components. That is correlations among variables are explained by underlying factors. Mathematically a one-factor model for three variables can be represented as follows (Vs are variables Fs are factors Es represent random error).

$$V_1 = L_1 * F_1 + E_1$$
$$V_2 = L_2 * F_1 + E_2$$
$$V_3 = L_3 * F_1 + E_3$$

Each variable is composed of the common factor (F_1) multiplied by a loading coefficient ($L_1L_2L_3$-the lambdas) plus a random component. If the factor were directly measurable (which it isn't) this would amount to a simple regression equation. Since these equations cannot be solved as given (the Ls, Fs and Es are unknowns), factor analysis takes an indirect approach. If the equations above hold, then consider why variables $V_1$and V_2 correlated. Each contains an error (the Es are assumed to be random or unique) component that cannot contribute to their correlation (errors are assumed to have O correlation). However they share the factor F_1 so if they correlate their correlation should be related to L_1 and L_2 (the factor loadings). If this logic is applied to all the pairwise correlations, the loading coefficients can be estimated from the correlation data. Thus one factor might account for the correlations in a set of variables. If not, the equations can be easily generalized to accommodate additional factor. There are different approaches to fitting factors to a correlation matrix (least squares, generalized least squares, maximum likelihood, etc.) which have given rise to a number of factor methods. A basic assumption of factor analysis is that the variables used in factor analysis are linear combinations of some underlying factors.

The idea of a principal component

A concept related to most methods of factoring is the idea of a principal component. A principal component is a linear combination of observed variables that is independent (orthogonal) of other components. The first principal component accounts for the largest amount of variance in the input data. The second component accounts for the largest amount of the remaining variance in the data and so on.

Varimax rotation

The ideal result of rotation is that each variable will have a high loading on a single factor (have a lambda coefficient near one) and small loading (near zero) on the other factors. Therefore, the net effect of rotation as well as its main motivation is to facilitate interpretation.

Varimax rotation attempts to simplify interpretation by maximizing the variances of the variables loadings on each factor (i.e., tries to simplify the factors).

Application of Factor Analysis in Fisheries sector: An example

In the present study, 15 profile characteristics of shrimp farmers in Nellore district of Andhra Pradesh, and one dependent variable namely the extent of adoption of shrimp culture technologies were used.

Factor loadings of profile characteristics with respect to extent of adoption of shrimp culture technologies

The results from the factor analysis explained the number and nature of relationship existing among the profile characteristics with the extent of adoption of shrimp culture technologies and the results are presented in Table 1.

Table 1. Factor loadings of profile characteristics with respect to extent of adoption of shrimp culture technologies (n = 60)

Sl. No.	Profile characteristics	Factor I	Factor II	Factor III	Factor IV	Communality
1.	Age	0.475	0.023	-0.1123	0.763	0.821
2.	Education	0.820	0.107	-0.092	-0.291	0.778
3.	Occupation	0.859	0.193	-0.087	-0.174	0.812
4.	Farm size	0.757	-0.069	0.022	0.371	0.7016
5.	Experience in shrimp farming	0.541	-0.373	0.583	0.066	0.776
6.	Annual income	0.049	0.795	0.279	0.179	0.744
7.	Family size	-0.090	0.787	0.394	0.118	0.797
8.	Ownership of shrimp farm	0.813	-0.250	0.058	0.181	0.760

9.	Marketing behavior	0.850	-0.151	0.244	-0.127	0.821
10.	Material possession	0.635	-0.027	0.515	-0.248	0.730
11.	Social participation	0.883	0.051	-0.167	-0.198	0.850
12.	Information seeking behavior	0.743	0.261	-0.231	-0.188	0.709
13.	Extension participation	0.506	0.419	-0.298	-0.065	0.525
14.	Economic motivation	0.557	0.009	-0.496	0.141	0.577
15.	Risk orientation	0.506	-0.169	0.118	0.194	0.336
Eigen values		6.454	1.806	1.360	1.132	
% of variation explained		43.029	12.040	9.069	7.548	
Cumulative % variation explained		43.028	55.068	64.137	71.685	

A close perusal of Table 1 gives the factor loadings, communalities, eigen values, and the percentage of variance explained by the factors. It could be seen from the table, that out of the 15 profile characteristics, five factors have been extracted and these five factors, together explain the total variance of these profile characteristics to the extent of 71.68 per cent.

The factors extracted as such are rarely interpretable and have only theoretical significance. It is therefore, necessary to rotate the factors, so that the rotated factors may be meaningfully interpreted. The varimax rotation was used to obtain meaningful interpretation, and the results are given in Table 2.

Table 2: Rotated factor (varimax) matrix of fifteen profile characteristics

Sl. No.	Profile characteristics	Factors			
		1	2	3	4
1.	Age	0.123	0.080	**0.889**	0.095
2.	Education	**0.779**	0.408	0.061	-0.028
3.	Occupation	**0.791**	0.391	0.173	0.070
4.	Farm size	0.376	0.422	**0.629**	0.010
5.	Experience in shrimp farming	-0.040	**0.853**	0.200	-0.082
6.	Annual income	0.108	-0.040	0.062	**0.852**
7.	Family size	-0.027	-0.024	-0.066	**0.890**
8.	Ownership of shrimp farm	0.407	0.565	0.489	-0.191
9.	Marketing behavior	0.492	0.734	-0.185	-0.081
10.	Material possession	0.293	0.789	-0.065	0.132
11.	Social participation	**0.807**	0.393	0.187	-0.096
12.	Information seeking behavior	**0.805**	0.198	0.134	0.068
13.	Extension participation	**0.675**	-0.055	0.151	0.209
14.	Economic motivation	**0.590**	-0.071	0.428	-0.201
15.	Risk orientation	-0.179	0.405	0.365	-0.080
Eigen values		4.030	3.080	1.938	1.704
% of variation explained		26.869	20.535	12.919	11.363
Cumulative % variation explained		26.869	47.404	60.322	71.685

An analysis of Table 2 shows the interpretation of the rotated factors in the varimax matrix. A total of four factors have been identified as having maximum percentage variance. Each factor column was scanned for identifying a few profile characteristics with significant high loadings. Thus from each factor column, the profile characteristics having a factor loading of more than **0.5** were selected. Thus the selected factor loadings from each factor column was selected and presented in Table 3.

Table 3: Profile characteristics with factor loadings under different factors for extent of adoption of shrimp culture technologies

Factor	Profile characteristics	Factor loadings
FACTOR I	Education	0.779
	Occupation	0.791
	Social participation	0.807
	Information Seeking behaviour	0.805
	Extension participation	0.675
	Economic motivation	0.590
FACTOR II	Experience in Shrimp farming	0.853
	Ownership of Shrimp farm	0.565
	Marketing behavior	0.734
	Material possession	0.789
FACTOR III	Age	0.889
	Farm Size	0.629
FACTOR IV	Annual income	0.852
	Family size	0.890

An analysis of Table 3 shows the groupings of the profile characteristics under each factor with respect to their factor loadings.

FACTOR I

The profile characteristics in the factors were identified as prime factor which explained 43.03 per cent of variance on the overall extent of adoption of technologies by shrimp farmers. These include social participation (0.807), information seeking behaviour (0.805), occupation (0.791) education (0.779), extension participation (0.675) and economic motivation (0.590). It could be seen from the table that the profile characteristics, social participation and information seeking behaviour had highest factor loadings followed by Education. Hence, this factor is labeled as "*socio-personal*" factor.

FACTOR II

From Table 3, it could be further noted that there were 4 characteristics which had significant loadings on factor III. They were experience in shrimp farming (0.853), material possession (0.789), marketing behaviour (0.734) and ownership of shrimp farm (0.565).All these characteristics are of personal importance and hence it has been labeled as "personal" factor. The second factor accounted for 12.04 per cent of the total variance.

FACTOR III

Age and farm size under this factor accounted for 9.07 per cent of the total variance. Of these two, age had a higher factor loading of 0.889, and hence this factor was termed as "individual" factor.

FACTOR IV

The two profile characteristics which had significant loadings on factor IV were family size and annual income. This factor accounted for 7.55 per cent of the total variance; and hence this factor was termed as "family" factor.

Conclusion:

In this study, factors analysis was used to group the variables into factors based on the communalities observed, and to find out the relative importance of each factor in accounting for the particular set of variables being analysed. The method of factor analysis used for the study was principal component analysis and the rotation method was varimax rotation. It could be inferred from the foregoing study that the *socio-personal* factor accounted for the maximum percentage of the total variation on the overall extent of adoption of technologies by shrimp farmers.

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10

DISCRIMINANT ANALYSIS: A METHOD FOR DETERMINING RELATIVE IMPORTANCE OF PREDICTOR VARIABLES

P.S. Swathi Lekshmi

Introduction

Discriminant analysis is a technique designed to characterize the relationship between a set of variables often called the response or predictor variables and a grouping variable with a relatively small number of categories. To do so, discriminant creates a linear combination of the predictors that best characterize the differences among the groups. The technique is related to both regression and multivariate analysis of variance and as such it is another general linear modeling technique. Another way to think of discriminant analysis is as a method to study difference between two or more groups of cases on several variables simultaneously. This technique was developed by Sir Ronald Fischer in 1936. Discriminant function analysis is useful in determining whether a set of variables is effective in predicting category membership. (Green *et al.*, 2008)

The Elements of a Discriminant Analysis

The general procedure of doing a predictive discriminant analysis (PDA) is outlined as follows.

1. A grouping variable must be defined whose categories are exhaustive and mutually exclusive.

2. A set of potential predictors must be selected. This is one of the most important steps, although in many real world applications, set of predictors will be limited by what is available in existing dataset.

3. Once the above two steps are accomplished, as with any multivariate technique the next job is to study the data to see if it meets the assumption of doing a discriminant analysis. It is also important to look for outliers and unusual patterns in the data and to look for variables that might not be good predictors. Univariate ANOVAs and correlations can be used to identify such variables.

4. The goal of a PDA is to correctly classify cases into the appropriate group. Given this, as with any multivariate technique parsimony is an important sub goal. This means, using the fewest predictors needed for accurate classification, although not necessarily the smallest set of classification functions. Fewer predictors will mean lower cost of data collection and easier interpretation.

5. The discriminant analysis must be specified and run using statistical software such as the SPSS. A method of model selection must be chosen and prior probabilities for group membership should be considered. A significant test is available to see whether the difference in group means on each function is due to chance or not. The relative importance (in terms of explained variance) of each function is also calculated.

6. Use the classification result to see how well cases have been placed in their known groups.

7. At least two statistics are available to examine the effect of individual predictors on the discriminant functions and in particular to decide whether a particular variable adds little to the classification ability of the model.

8. Look for outliers in the data and examine cases that have been misclassified to check for problems and to see if and how the model can be re-specified.

9. Finally, it is of the utmost importance that the model be validated by some procedure.

The Discriminant Model: Methodological Framework

Discriminant function analysis is a statistical technique which allows for the study of the differences between two or more groups with respect to several variables simultaneously and provides a means of classifying any object / individual into the group with which it is most closely associated and for assessing the relative importance of each variable used to discriminate between different groups. A linear combination of predictor variables, weighted in such a way that it will best discriminate among groups with the least error is called a linear discriminant function and is given by:

$$D = L_1X_1 + L_2X_2 + \cdots + L_KX_K$$

Where, X_1, X_2 …. X_k are predictor variables, L_1, L_2 …. L_K represent the discriminant coefficient, and D is the value of the discriminant function of a particular individual, such that if this value is greater than a certain critical value D, the individual is classified in group I (e.g. a high adopter group), and otherwise the individual would be classified in group II. (e.g. a low adopter group). In the foregoing example, the respondents were classified into two groups, namely low adoption group and high adoption group, based on the mean adoption score. The predictor variables used for the study were the attributes of shrimp culture technologies, perception of cost of technologies, and perception of policies affecting shrimp culture.

Discriminant Analysis: An example from fisheries sector

Discriminant function analysis in relation to 12 attributes, cost and policy between the high and low adoption categories of 60 shrimp farmers of Nellore, Andhra Pradesh was studied. (Lekshmi *et al*., 2007)

The Mahalanobis D^2 value and discriminant function coefficient were computed, to find out the difference between the attributes, cost and policy perceptions of high and low adoption categories of shrimp farmers of Nellore when all the fourteen variables (twelve attributes, perception of cost, and policy) were considered together. The results are presented in Table 1.

Table 1: Discriminant function analysis in relation to the relative importance of variables in discriminating between the groups (n=60)

Sl. No.	Variables	Discriminant function coefficient l (i)	Relative importance (%)
	Efficiency (X_1)	1.0584	100.78
	Feasibility (X_2)	0.4455	-0.788
	Immediacy of returns (X_3)	0.0194	0
	Physical compatibility (X_4)	-0.0433	0
	Observability (X_5)	-0.1857	0
	Profitability (X_6)	-0.4232	0
	Perceived risk (X_7)	0.5651	0
	Input availability (X_8)	-0.4461	0
	Cost (X_9)	0.2485	0
	Total		100

Note: D^2 = 0.3505 High group (n_1) = 31 Low group (n_2) = 29 f = 20.56**

As could be seen from Table 1, the D^2 value was found to be 0.3505 and the f value was found to be highly significant at one per cent level of significance. Therefore, it could be concluded that the fourteen variables (consisting of perception of twelve attributes, perception of cost and perception of policy) were significantly discriminating between the high and low adoption categories of shrimp farmers.

Thus the null hypothesis, that there will be no difference between the perception of attributes, cost and policy by high and low adoption categories of shrimp farmers is rejected.

Table 1 reveals that out of the fourteen variables studied, 8 variables had shown significant positive influence in differentiating the high from the low adoption categories of shrimp farmers. The 8 variables in the descending order of their importance were efficiency (1.0584), perceived risk (0.5651), feasibility (0.4455), policies (0.3330), cost (0.2485), complexity (0.04313), immediacy of returns (0.0194), and multiple advantages (0.0055).

This indicated that the increased differential scores in these variables would increase the difference between the high and low adoption categories. It suggested that the respondents who scored high in these variables (individuals having higher perception of efficiency, perceived risk, feasibility, policies, cost, complexity, immediacy of returns, and multiple advantages, might have differentiated more significantly between the high and low adoption categories, among the shrimp farmers.

The analysis also revealed that the remaining 6 variables viz., input availability (-0.4461), profitability (-0.4232), trialability (-0.3247), observability (-0.1857), physical compatibility (-0.0433) and cost of technologies (-0.0163) had shown significant negative discriminant function coefficients in the descending order of their importance. The analysis also revealed that these variables had shown significant negative influence in differentiating the high adoption category and low adoption categories. This suggested that the respondents who scored high in these variables (respondents with high perception of input availability, profitability, Trialability observability, physical compatibility and cost of technologies) might have differentiated less between the high and low adoption categories of shrimp farmers.

Further observation of Table 1, shows the relative importance of the variables in discriminating between the high and low adoption categories. It could be seen from the table that the variables having substantial importance in the classification of shrimp farmers in to the high adoption category (first group) and low adoption category (second group) were efficiency and feasibility with a relative importance of 100.78 and–0.788 percent respectively.

The Discriminant function fitted was, $D = L_1X_1 + L_2X_2 + \cdots + L_KX_K$, where D is the value of the discriminant function of an individual shrimp farmer, X_i's are the predictor variables and Li's represents the discriminant coefficients. The estimated function takes the form following form:

$D = 1.0584\ X_1 + 0.4455\ X_2 + 0.0194\ X_3 - 0.0433\ X_4 - 0.1857\ X_5 - 0.4232\ X_6 + 0.5651\ X_7 - 0.4461\ X_8 + 0.2485\ X_9 + 0.04313\ X_{10} - 0.3247\ X_{11} + 0.0055\ X_{12} - 0.0163\ X_{13} + 0.3330\ X_{14}$

The significance of the function was tested using the following analysis of variance presented in Table 2.

Table 2: Analysis of variance for discriminant function

Source	Degrees of freedom	Sum of Squares	NS	F-Value
Between population	14	2.73	0.19	20.56**
Within population	15	0.42	9.48	

Discriminant scores for categories I and II were

$D_1 = 5.3149$ $\qquad$ $D_2 = 5.0055$

$D^* = \frac{5.314+5.005}{2} = 5.16$, where D* is the critical value

If the Discriminant score, D is greater than the critical value (D*) then the individual is assigned to the first category i.e., high adoption category, otherwise the individual is assigned to the second category i.e. low level of adoption. The classification of the shrimp farmers into high and low adoption categories is presented in Table 3.

Table 3: Classification of respondents in to high and low adopter categories based on discriminant function (n=60)

Adopter category	Assigned locations using discriminatory function		Total
	High	Low	
High	30	1	31
Low	28	1	29
Total	58	2	60

From Table 3, it is observed that, out of the 60 farmers in Nellore district, 31 farmers were correctly classified. Hence the percentage of correct classification is 51.66 per cent. The significance of the F value as well as the per cent of correct classification of shrimp farmers, using the observed values, clearly indicates the overall significance and adequacy of the model.

Conclusion:

The discriminant analysis helps us in finding out the independent variables which best differentiate between two given categories of individuals or cases. It also helps to classify or assign individuals to a particular category to which they belong. It helps researchers and technology developers in analyzing the important attributes of a particular technology which would help in increasing its adoption among end users.

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11

QUANTIFICATION OF EMPOWERMENT INDEX OF FISHERY SELF HELP GROUPS

Vipinkumar V.P.

Introduction

In the paradigm of Gender mainstreaming, we generally focus on equity and equality of both men and women the praxis of which is manifested through empowerment. Empowerment is a process whereby women become enlightened, and thus, increase their own self-reliance to assert their independent right to make choice and control over the resources. This would assist them in challenging and eliminating the factors that subjugate them. The Self Help Groups (SHG), being the grass root level institution for improving the life of women on various social, political and economic components, play a vital role in bringing about women empowerment in our country. Women empowerment can be operationally defined as the difference in the extent of empowerment level of women in the present context between the empowerment level prior to the formation of SHG, based on the sub-dimensions, such as confidence building, self esteem, decision making pattern, capacity building, psychological empowerment, social empowerment, economic empowerment and political empowerment. Empowerment Index, which has got immense practical utility, is used to assign an order of priority to the measured empowerments, by comparing them among themselves.

Now let's see the various sub-dimensions of empowerment in detail with a measurement perspective as given below:

1. **Confidence building:** It depicts the extent to which an SHG member is confident to participate in various discussions within and outside the SHG and also to use the skills acquired through SHG. The different categories included are confidence built within family, confidence built within SHG, confidence built within public meetings, improvement in technical and practical skills through training, acquisition of skills for income generation, use of skills for income generation, development of managerial skills, ability to facilitate a group meeting and addition to literacy/education.

2. **Self-esteem:** Self-esteem of group members is measured to assess how the members perceive their own image in different areas. It is worked out by keeping four major variables viz., self-image in the family, self image in the community, self reliance/Independence and feeling of security.

3. **Decision making pattern:** It is the degree to which the respondent makes a decision regarding children's education, family planning, buying and selling land, property and households, family and social functions and finally in Group meeting/Public gatherings.

4. **Capacity building:** It is determined on the basis of the ability of members to take risk, understand and solve problems, try new ventures and ability to take criticism.

5. **Psychological empowerment:** The level of psychological empowerment is measured by the SHG members' perception about future and satisfaction. The two major components used for measuring psychological empowerment are hope and overall satisfaction.

6. **Social empowerment:** Social empowerment is measured, covering the aspects such as team spirit, communication skill, participation in group activity, leadership, reduction in domestic violence, attitudes towards dowry, superstition, freedom and empowerment of women.

7. **Economic empowerment:** It refers to the economic background of SHG members. For measuring the level of economic empowerment, four major variables are selected. These variables include making household purchase, income, indebtedness and repayment, access to loan and control of use of credit.

8. **Political empowerment:** It is the degree of perception of SHG members towards political aspects. The variables included for measuring the level of political empowerment are participation in *Panchayat Raj* elections and changes in political views.

For the computation of Empowerment Index (Em I), the scores obtained for each of the above mentioned sub dimensions are made uniform. These scores are then added to get the EmI score of each respondent.

Utility of Empowerment Index

Empowerment Index is used to assign an order of priority to the measured empowerments, by comparing them among themselves. An empowerment index is employed to rank the identified sub dimensions of empowerment like confidence building, self esteem, decision making pattern, capacity building, psychological empowerment, social empowerment, economic empowerment and political empowerment. There is immense practical utility of this Index as it is often inevitable in social sciences, to assess the extent of empowerment and capacity building initiatives of group enterprises and independent ventures. The scale can be used in similar future research aspects for measuring the effectiveness of the group for larger applications ensuring sustainability.

Computation Technique of Empowerment Index

All these sub-dimensions are measured by a set of inventories containing appropriate questions arranged in a three-point continuum of "always, sometimes and never" with scoring pattern 3, 2 and 1 for positive and vice versa for negative questions. An empowerment index is employed to rank the identified sub dimensions of empowerment. The responses from the SHG members are collected under two conditions, i.e., before joining the SHG and after joining the SHG. By totaling the value assigned to each dimension of an empowerment component, an actual score was obtained for each empowerment component. Minimum and maximum values are set in order to transform the actual scores into indices between 0 and 1. Standardization is done to make it unit free using below given formula.

$$\text{Empowerment index} = \frac{(\text{Actual score} - \text{Minimum score})}{(\text{Maximum score} - \text{Minimum score})}$$

Based on the score obtained on the empowerment index, empowerments are classified into low (Up to 0.33), medium (0.33-0.66) and high (above 0.66) based on the score obtained on the empowerment index. An actual score is obtained for each empowerment by totaling the value assigned to each dimension of an empowerment. Minimum and maximum values are set in order to transform the actual scores into indices between 0 and 1. Standardization is done to make it unit free using below given formula, empowerments are classified into low, medium and high.

In the standardization of the Empowerment Index scale, each dimension is assigned weightage by expert judges and the actual score obtained for each dimension by totaling the sub-dimensions, will be multiplied with the corresponding weightages by scale product method and then compute the empowerment index score. The dimensions with weightages and sub-dimensions of Empowerment Index are as follows:

Self-confidence (weightage 1):

❖ Confidence built within family

❖ Confidence built within SHG meetings

❖ Confidence built within public meetings

❖ Improvement in technical and practical

- ❖ Skills through training
- ❖ Acquisition of skills for income generation
- ❖ Use of skills for income generation
- ❖ Development of managerial skills, ability to
- ❖ facilitate a group meeting
- ❖ Addition to literacy/education

Self-esteem (weightage 1):

- ❖ Self image in the family
- ❖ Self image in the community
- ❖ Self –reliance/Independence
- ❖ Feeling of security

Decision making pattern (weightage 1.1):

- ❖ Children's education
- ❖ Family planning
- ❖ Buying and selling land, property and households
- ❖ Family and social functions
- ❖ SHG meeting/Public gatherings

Capacity building (Weightage 1.4):

- ❖ Ability to take risk
- ❖ Ability to understand and solve problems
- ❖ Ability to try new ventures
- ❖ Ability to take criticism

Psychological empowerment (Weightage 1.1):

- ❖ Hope
- ❖ Overall mental satisfaction

Social empowerment (Weightage 1.6):

- ❖ Team spirit
- ❖ Communication skill
- ❖ Reception skill
- ❖ Processing skill
- ❖ Expression Skill
- ❖ Feedback orientation
- ❖ Participation in group activity
- ❖ Leadership
- ❖ Reduction in domestic violence
- ❖ Attitudes towards dowry, superstition freedom and empowerment of women

Economic empowerment (Weightage 1.8):

- Make household purchases
- Income, Indebtedness and repayment
- Access to loan
- Control of use of credit

Political Empowerment (Weightage 1):

- ❖ strong political stand
- ❖ improvement in the political views
- ❖ during SHG stabilization
- ❖ after self help phase

Output and interpretation of results

A practical example of assessing the extent of Empowerment of SHG members: Empowerment index was specifically modified in this context and was used to analyze the extent of empowerment of women through the formation of SHGs in the green mussel growing belts of Kasargod and Kozhikode districts of Kerala under the research project titled 'Gender Main streaming and Impact of SHGs in Marine Fisheries Sector of Kerala'. To achieve the objectives of the study, information was collected on selected sub-dimensions before and after the respondent woman had joined SHG. Difference between before and after index was taken as the extent of empowerment of SHG members. It was observed from Table 1 that, prior to the formation of SHG, the overall empowerment (combined score of all the eight empowerment variables) was found to be medium (0.34). In case of individual empowerment variables, respondents possessed medium empowerment in decision making (0.38), confidence building (0.35), self-esteem (0.34), and social empowerment (0.34). Joining in the SHG helped the members to attain higher empowerment for decision making, self-esteem, confidence building, capacity building, social empowerment, and economic empowerment. Among these, the variable with highest empowering potential, namely decision making pattern was ranked highest with an index value of 0.79 followed by confidence building (0.78).

Table 1. Extent of empowerment level through entrepreneurial activities of fishery SHGs

Sl. No.	Parameters	Before (Mean Score)	After (Mean Score)	Shift
	Confidence building	0.35	0.78	0.43
	Economic empowerment	0.33	0.75	0.42
	Decision making pattern	0.38	0.79	0.41
	Self-esteem	0.34	0.72	0.38
	Social empowerment	0.34	0.72	0.38
	Capacity building	0.32	0.67	0.35
	Political Empowerment	0.28	0.62	0.34
	Psychological empowerment	0.30	0.66	0.33
	Overall empowerment	0.34	0.73	0.39

Note: On an average the SHGs were found to be 8 years old.

It was observed that, in building the confidence of women, the SHG has played a major role. The second change was observed in economic empowerment *i.e.* from low (0.33) to a high (0.75) level of empowerment. Psychological and political empowerments are found to shift from low to a medium level of empowerment. Similarly, Das (2012) had reported that about 73 percent of the SHG members remarked that, their participation in the political process was almost nil in the Barak valley of Assam. Overall empowerment was found to shift from medium level of empowerment to high level of empowerment.

The SHGs undertaking value addition activity in fisheries were found to possess higher confidence and economic empowerment. Members in the value added activity participated in many exhibitions for representing their group and variety products developed by them and this increased their confidence compared to other groups. The profit received per individual was also observed to be higher for value addition activity group. Overall empowerment was found to be more in those SHG members who are engaged in value addition, aided by their higher involvement in the activity. It was observed that, confidence building was significantly associated with involvement in the entrepreneurial activities of SHGs and economic empowerment. This depicted that, confidence was developed through economic activities that raised the income of the respondents. Self-esteem depicted self-image in the family and society, self-reliance and feeling of security was found to be significantly and positively associated with education, extension contact, training attended, and involvement in the activity. This showed that, self-esteem had positive association with interpersonal communication network. Decision making pattern was positively and significantly associated with involvement in the entrepreneurial activities. This depicted that entrepreneurs had to take decisions on their own without considering their image (self-esteem). Psychological empowerment was found to be significantly and positively associated with extension contact and involvement in the entrepreneurial activities. This indicated that, the hope and overall satisfaction might have come through interpersonal interaction with change agents for better economic involvement which also improved the image of the person in the community. Economic empowerment was observed to be positively and significantly associated with education, type of family and involvement in the entrepreneurial activity.

Conclusion

For the development of women entrepreneurship, political and social empowerment of women are essential for reducing unemployment in the rural areas in India and these can be achieved through the formation of SHGs. Overall empowerment, in the example given above, was found out by adding the scores of all the eight empowerment dimensions. This was observed to be varied across the districts and between the activity groups. The number of women inclined towards SHG is increasing, which implies that, women are aspiring for empowerment. There was a subtle increase in self-confidence, economic empowerment and decision making pattern of women due to the involvement in the entrepreneurial and other activities of SHGs. However, much needs to be done to improve the contribution of extension contact, training on confidence building and economic empowerment. This scale on Empowerment Index can be used for measuring the extent of empowerment of SHGs of both men and women in any key areas on a sustainable basis.

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12

METHODOLOGY ON VALUATION OF ECOSYSTEM SERVICES OF CORAL REEFS

R. Geetha

Introduction

Natural resources are boon to mankind. Economic progress of any country depends on the extent, quality and availability of natural resources. Currently, these resources are fast depleting due to various natural processes and anthropogenic activities. Through ecosystem valuation, it is possible to get a fair idea on the rate of depletion of different natural resources over time. Valuation is an attempt to put a monetary value on a certain asset, which can be tangible or intangible. Valuation is the heart of environmental economics and is emerging as a very active and rapidly expanding field. The basic strategy for environmental valuation is the co-modification of the services that the natural environment provides. The need for valuation arises from the fact that most environmental goods and services are not traded in the market and hence don't have a price. Examples are air and water quality or forest preservation. This does not imply that these goods and services don't have a value; only that market fails to capture it directly ('market failure'). The purpose of environmental valuation is to reveal and translate into monetary terms the true costs and benefits of alternative decisions regarding public goods such as environmental resources. It provides important information to guide the allocation of scarce public resources.

Economic valuation of ecosystem services

Economic valuation is the process of identifying the relevant changes in consumer demand and producer supply arising from a (project-induced) change in environmental quality, or the change in the provision of an environmental resource. In brief, environmental valuation is concerned with the analysis of methods for obtaining empirical estimates of environmental values, such as the benefits of improved river water quality, or the cost of losing an area of wilderness to development. The most commonly used approach is based on the concept of total economic value (TEV). Environmental valuation is largely based on the assumption that individuals are willing to pay for environmental gains and, conversely, is willing to accept compensation for some environmental losses.

Importance of environmental valuation

Most of the environmental goods and services have no price but have value. These resources are so important to be valued as they perform a large number of ecological functions that a society enjoys like clean air, ecological balance nutritional recycling, aesthetic beauty etc. So, broad reasons for valuing these resources are:

- ❖ To ensure optimal & sustainable resource level.
- ❖ There is the situation of missing markets.
- ❖ Even if there are markets, they are not performing well.
- ❖ For environmental goods and services, it is essential to understand and appreciate its alternatives and alternatives uses.
- ❖ Governments may like to use the valuation as against the restricted, administered or operating market prices for designing natural resources conservation programmes.
- ❖ In order to arrive at environmental accounting for methods such as net present methods or cost- benefit

analysis, valuation is a must.

- ❖ Facilitate land use decisions.
- ❖ Limit or ban trade in endangered species.

With this background, various methodologies used to estimate the valuation of ecosystem services of coral reefs are given below:

Methodology for Valuation of Coral Reefs

Millennium Ecosystem Analysis (MEA)

Coral reefs are highly productive, diverse, and attractive ecosystems which provide a valuable range of goods and services for mankind. Valuation of goods and services generated by coral reef system had widely been attempted by researchers in different parts of the world. Millennium Ecosystem analysis (MEA) has conceptualized the ecosystem services framework as (1) provisioning services such as supply of food, building materials and medicines, (2) regulating services such as shoreline stabilization, flood prevention, storm protection, climate regulation and carbon sequestration (3) cultural and recreational services such as culture, tourism, and recreation and (4) supporting services such as habitat provision, nutrient cycling, primary productivity and soil formation. Therefore, complex valuation techniques are used to arrive at an economic value of coral reef services. To ascertain the Economic Value of coral reefs in study area, special attention had been given mainly to eight types of goods and services provided by coral reef systems:

1. Fisheries (Change in productivity method)
2. Tourism (travel cost method)
3. Coastal Protection (Replacement cost method)
4. Erosion prevention (Replacement cost method, Benefit transfer method)
5. Biodiversity (Bio prospecting) (Benefit transfer method) (Option value)
6. Research
7. Donations by NGO and various organizations (Bequest value)
8. Existence value (Contingent valuation method)

The main advantage of calculating the TEV is to obtain a figure of the value of the reef ecosystem, which will highlight to stakeholders and policy makers the importance of the conservation of the reef ecosystem.

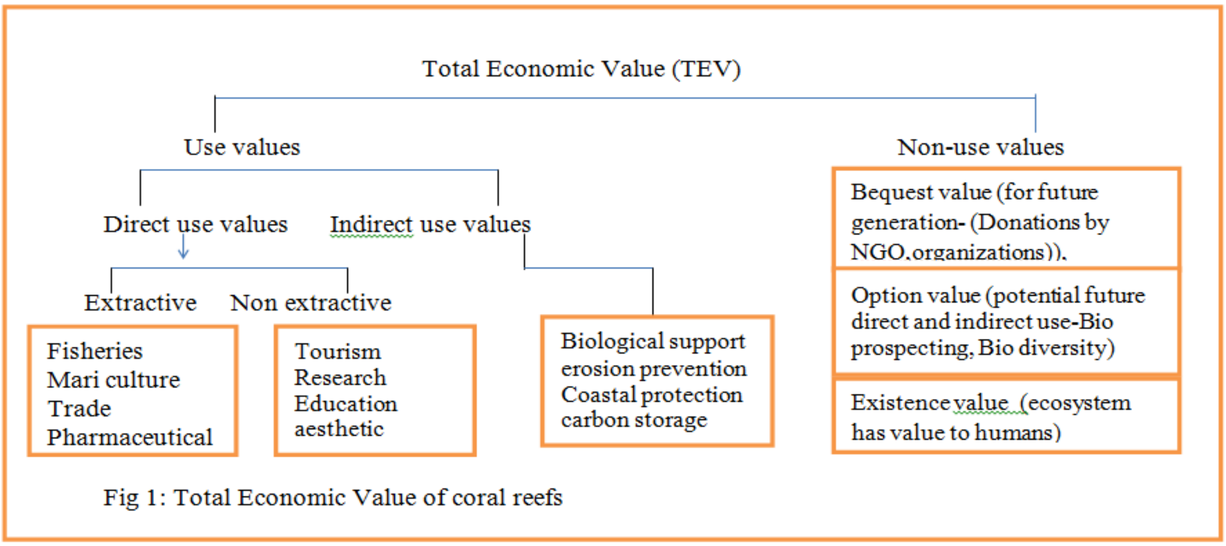

Fig 1: Total Economic Value of coral reefs

Valuation of Coral Reef Fisheries

In the context of present study, the value of coral reef-associated fisheries will be estimated using a financial analysis approach and involves calculating the revenue generated from fisheries of study area. Two major streams of fisheries related revenues will be considered. They include: (i) net revenue of fisheries at the landing centre (major part of this revenue is distributed among the fishermen) and (ii) the revenue generated from value added fisheries i.e. the export based revenue (major part of this revenue is distributed among fish traders and fish processing units)

Net revenue of fisheries at the landing centre

The fish catch data from 2000-01 to 2015-16 to be collected to study trend over the period of time in study area (Table 1). CPUE (catch per unit effort) also has to be studied to analyze the fishing pattern in the study area.

Table 1: Dummy table for species /group wise fish catch (in Tons) in study area

Local name	Common name	2012-13	2013-14	2014-15	2015-16
Total					

At fish landing centres, the gross revenue of fisheries is to be estimated based on species wise fish catch and their sale price. From this, the net revenue is estimated by subtracting operating costs. Literature suggests that on an average the operating cost (including the labor and non labour) in marine fisheries is around 25% of the gross revenue (Burke *et. al.* 2008). In addition to above overall fish valuation, the valuation specifically focuses on fisheries that depend directly on coralline area for at least a portion of their life-cycle. Therefore, any positive or negative changes in coral reef health (e.g. coral bleaching) will have significant impact on fish productivity and total revenue generation. Accordingly, average annual catch value for entire region and coral associated fishing areas is to be estimated. Out of this, contribution of coralline areas in annual fish catch in value and per cent has to be worked out.

Revenue generated from value added fisheries (Export)

To estimate the export value of fish catch, the total volume of fish export from study area is to be estimated and, along with the actual value addition done through fish processing for export purpose (Table 2). Since, fish processing and export units in the region may not share specific data on processing volumes and revenue, the cost of value addition is difficult to estimate. Similarly, the export volume would not be available at disaggregated level. Therefore, these values can be approximated based on available information and expert knowledge.

Export of various products of marine fish is one of the key revenue generators for the State of Tamil Nadu. A range of fish products are exported to different countries and regions. Export details of marine fish products of Tamil Nadu may be collected and compiled from MPEDA annual reports.

Further, the summary on coral associated fishery value may be estimated based on the various categories such as gross revenue, operating costs, value addition, etc. and adjusted for the coral reef area associated with the fishery (Table 3).

Table 2: Dummy table for state of catch & export (in tons) and value of fisheries products

Year	Marine Catch	Inland Catch	Total Catch	Total Export	Total Export Value (Million Rs.)	Unit Value (Rs./kg.)
2007						
2008						
2009						
2010						
2011						
2012						
2013						
2014						
2015						
2016						
Average						

Table 3: Dummy table on summary of coral associated fisheries values in study area

S.No	Parameter	Value (in lakhs Rs.)
1.	Commercial Fisheries – Gross Revenue (A)	
2.	Operating Costs (% of Gross Revenue)(B)	
3.	Commercial Fisheries – Net Revenue (i.e. A - B)(C)	
4.	Value addition (i.e. Export) (D)	
5.	Total Net Value (C+D)	
6.	Total coral reef area (km2)	
7.	Coral Reef Associated Fish Value (lakh Rs. / km2 /year)	

Valuation of coral reef tourism and recreation

Tourism and recreation constitute the most highlighted economic benefits of the coral reef systems. The key tourism activities associated with coral reefs include the SCUBA diving, reef walking etc. They are the direct use values attributable to coral reefs and are usually estimated by accounting for the tourism revenue generated by a particular coral reef destination. Most of the studies focused on coral reef recreation/tourism estimate consumer surplus using a travel cost method (TCM) or Contingent Valuation Method (CVM).

In the present context, economic value of tourism and recreation related to coral reefs in study area can be assessed by using a travel cost method with main focus on the expenditure pattern of tourists associated with the coral tourism.

Also, the expenses incurred by students who attend nature education camps in the study area will also be considered and included as educational tourism. While, the estimate of numbers of tourists in the study area could be provided by park managers, to record expenditure pattern of tourists who visits different coral reefs locations of study area, a questionnaire-based primary survey of tourists can be conducted (Table 4). The extent to which tourism can develop depends on expansion of infrastructure, basic amenities and marketing linkages.

Based on the feedback from the respondents at different sites, the expenditure pattern during the stay at study area to visit coral reefs can be recorded. The expenditure is broadly classified into three major categories namely lodging, transport, food and official entry fees. Visitors may be differentiated as foreigners, domestic and local tourists. In addition, students visiting study area for viewing coral and other marine lives as part of their environmental/nature education program may also be considered in the study. Per person expense related to coral associated tourism varies in different site. Also, the expense pattern varies between Indian and foreign tourists (Table 5).

Accordingly, based on the feedback from the respondents and assuming that each tourist visits the site once a year, per head expenses for study area could be estimated per year. In addition, students who visit the study area as part of nature education camps will incur for one day camp. These values could be added along with tourism value. Thus, by applying expenditure method, annual value of tourism and recreation can be estimated. The above values will be used to estimate the tourism value in terms of per unit area of coral reefs in study area (Table 6).

Table 5: Tourism related expenses for different coral reef sites in study area

Type of Tourist	Site	Total Tourists	Per person expenses incurred (Rs.)	Total Annual Value (Rs.)
Indian				
Foreigner				
Total (Tourism)				
Education				
Grand Total				

Table 6: Total annual tourism value of coral reefs in study area

Parameter	Study area
Coral Reef Area2 (sq. km.)	
Value of Coral Reefs (Rs./sq. km./year)	

Coastal protection value of coral reef

Preventive Expenditure on Salinity Control

Salinity ingression in ground water of coastal areas is a growing problem in terms of huge monetary loss in agriculture production. Realizing the magnitude of this problem and to tackle this problem, concerned governments and various national and international organizations incur expenditure on various schemes. However, all of the above 'mitigative expenditures' cannot ascribed to replacement for coral reef function, because as such most of the mitigation measures are simply to deter excessive pumping of ground water and facilitate ground water recharge. So the value of coral reefs in preventing the salinity ingression is assumed as 15%. In recent years, TN Government and various organizations has undertaken artificial reef installation at various places of Tamil Nadu to increase biomass and protect the coastal wealth. The budget allocation for those schemes in the study area can also be included to estimate coastal protection value of coral reef (Table 7).

Table 7: Dummy table on total coastal protection value of coral reef

items	Value (In Rs)
Preventive Expenditure on Salinity Control	
Budget for artificial reef installation	
Total	

Value of coastal Erosion prevention by coral reef

Coral reefs act as wave breakers and thereby fulfill an essential function of coastal protection. They act as natural sea walls and in coastal areas that are devoid of coral reefs, authorities need to spend huge sums on manmade protection. In addition, the ability of the reef to act as an effective buffer zone depends on the state of the reef. The coastal protection prevention function of coral reefs will be valued by applying Benefit Transfer Method (BTM). In addition, preventive expenditure data by Govt. Agencies to control the coastal erosion problem can also be analyzed (Table 8).

Benefit Transfer Method (BTM) is used when values derived and used in other comparable studies are transferred and adjusted to find and estimate the values in the current study. The logic is that a study carried out in the similar circumstances and location can be used as a substitute and a proxy for another area, especially if the data is inadequate for the study site and the time for the study is also restricted. The BTM estimates the net benefit of a similar environment from an existing study and transfers it to a new context assuming that existing values can be used as an approximation.

To reduce the transfers errors, the adjustments and scaling up and down of the data have to be done with regards to site specific characteristics like socio-economic variables like per capita income and geographical differences etc. at the macro level. It is mostly used for site to site transfers of values and cannot be applied to the whole ecosystem. Thus, in this context, attempts need to be made to apply benefit transfer approach for valuation of biodiversity, coastal protection and ground water quality maintenance (control of salinity ingression). While, the outcomes of studies in differ parts of globe provide sufficient information that can be used in BTM approach, the results of those coral reef systems which are geographically and socio-economically closer to study area, actually provide greater power for value transfer.

Table 8: Dummy table on coastal erosion prevention values in other coral reef areas

Parameters	Unit	Other area 1	Other area 2
Estimated coastal erosion prevention value (eg.,2003)	Lakh Rs		
Adjusted coastal erosion prevention value (2016)	Lakh Rs		
Adjusted coastal erosion Prevention value (2016)	Rs per sq. km.		

The second level of adjustment (value transfer) has to be done using different ecological and economic parameters. Thus for the present purpose, (i) ratio of reef flat to coastal margin, (ii) population density (iii) per capita income and (iv) contribution of agriculture product in GDP may be adjusted to estimate the value by benefit transfer approach (Table 9).

Table 9: Dummy table on parameters and their values used for applying Benefit Transfer Method

Parameters	Unit	Other area 1	Other area 2	Study area
Reef Area	Sq. km.			
Length of shoreline	km			
Ratio of Reef Area to Coastal margin (shoreline)	Sq. km./km			
Population density	No. per sq. km.			
Per Capita Income	Rs			
Value Added in Agriculture	% of GDP			

Accordingly, using different parameters that are considered to have influence in defining the value of coral reef associated coastal erosion prevention in other regions the estimated values of coastal erosion prevention function for study area can be arrived at (Table 10).

Table 10: Dummy table on estimated coastal erosion prevention value of coral reefs in study area (Rs. Per km^2)

Parameters Used for Benefit Transfers	Transferred Values from other region	Transferred Values from other region
Ratio of Reef Area to Coastal margin		
Population density		
Per capita income		
Value Added in Agriculture		
Average		

Preventive Expenditure on Coastal Protection

To analyze the economic contribution of shoreline protection services provided by coral reefs in study area, valuation of the shoreline protection services provided by the artificial reefs, are necessary based on the costs required to replace them by artificial means. In addition to that, central government funding for various schemes and projects for coastal protection are to be taken care of. It is also important to note that the entire estimated monetary value of artificial reef and schemes cannot be attributed to the coral reefs protection. Based on coral experts and literature, we can assign some per cent as preventive expenditure of coral reefs. If we have sufficient data on preventive expenditure, value can be directly estimated (Table 11). Or else benefit transfer approach will be more suitable for this purpose.

Table 11: Dummy table on total coastal erosion prevention value of coral reef

Items	Value (Rs)
Estimated Coastal Erosion Prevention Value by benefit transfer method	
Preventive Expenditure on Coastal Protection	
Total	

Coral reef biodiversity valuation by benefit transfer method

In terms of economic valuation, biodiversity is potentially the most significant value of marine products. Realizing the fact that the limited knowledge exist about the biodiversity pattern, its economic valuation is considered a difficult task. However, for the present study, maintenance of biodiversity function of coral reefs can be valued by applying Benefit Transfer Method (BTM) (Table 12).

Table 12: Dummy table on bequest value estimation of coral reef bio diversity

Donors	2011-12	2012-13	2013-14	2014-15	Average
Global Environment fund					
NGO					
Various organizations					
Private, Industries					
Indian govt.					
State govt.					
Total					

Bio-prospecting potential

Scientific research that looks for a useful application, process, or product in nature is called biodiversity prospecting, or bio-prospecting. Bio-prospecting (the exploration of biodiversity for new biological resources of social and economic value) has yielded numerous products derived from species in coastal and marine ecosystems (for example, antibiotics, antifreeze, fibre optics, and antifouling paints).

Table 13: Biological activities recorded from different marine species from Indian coast.

Animal group	Species	Location	Recorded Biological Activities
Soft Coral	*Heterogorgia flabellum*	Kanyakumari, Tamil Nadu	Antiviral (Encephalomyocarditis virus)
Soft Coral	*Lobophytum pauciflorum*	Havelock, Andaman	Diuretic
Hard Coral	*Acropora corymbosa*	Kadmal island, Lakshadweep	Cardiovascular effect
Hard Coral	*Acropora formica*	NA	Diuretic, Toxic
Hard Coral	*Acropora humilis*	Kadmal island, Lakshdweep	Antiviral (Ranikhet disease)

Coral reefs are exceptional reservoirs of natural bioactive products, many of which exhibit structural features not found in terrestrial natural products. The pharmaceutical industry has discovered several potentially useful substances, such as cytotoxicity (useful for anticancer drugs) among sponges, jellyfish and starfish. Some of the recorded biological activities of coral reefs are presented in Table 13. This exciting opportunity of bio prospecting is in its infancy in India. CMFRI has recently developed extracts from green mussel and seaweeds, which are reported to relieve pains from arthritis. The particulars for estimating the biodiversity and bio-prospecting value of coral reef are presented in Table 14.

Table 14: Dummy table on total estimated bio diversity and bio-prospecting value of coral reef

Items	Value (Rs)
Estimated biodiversity value by benefit transfer	
Bequest value estimation	
Bio prospecting option value by Benefit transfer method	
Total	

Valuation of coral reef research

The research value of reefs can be approximated by estimating the amount of money spent on reef-related research in study area. There is a number of other reef-related research activities in coral reef is being carried out. In addition to that, students pursue their research in coral reefs for their master's degree and doctorate. These study expenses of particular area can be considered for number of years and average research expense can be worked out as detailed in Table 15.

Contingent valuation method(CVM) (Existence value): Willingness to pay questionnaire can be developed to estimate existence value of coral reef in study area. Respondents are to be given number of questions on coral reef protection, based on which the existence value can be arrived at.

The data on tourism, fisheries, coastal protection, research, biodiversity and bio prospecting will together form the basis for the overall valuation of ecosystem services from coral reefs. A summary of the various valuation techniques and the estimates arriving out of them are summarized in Table 16.

Table 15: Dummy table on research expenses on coral reef (Rs.)

Particulars	Institutes	2012-13	2013-14	2014-15	2015-16	Average
Research organizations	CMFRI					
	Institute of Oceanography					
	Madurai Kamarajar university					
	Anna university					
	State government					
	Central govt. research					
	Others					
	Others					
Students research (Master, Doctorate, Post doctorate)	M Sc.					
	Ph. D.					
	Post doctorate					
Marine Protected areas (MPA)	Maintenance cost					
	Research expenses					
	Entry fee					
Private research	Medical research					
	Coral mining research					
	Foreign					
	Various organizations					
	NGO					
Total						

Table 16: Dummy table on total estimated economic value of coral reefs in study area by Millennium approach

S. No.	Goods & Services	Method	Total Annual value (Million Rs.)	Value per unit area of coral reefs (Rs. per sq. km. per year)
1.	Fisheries	Change in productivity method		
2.	Tourism & Recreation	Travel cost method		
3.	Coastal protection &Protection against Salinity Ingression	Productivity Change & Preventive Expenditure Measure		
4.	Protection Against Coastal Erosion	Replacement cost method & Benefit Transfer Method (BTM)		
5.	Maintenance of Biodiversity (Option value)	Benefit Transfer Method (BTM)		
6.	Research	Expenses by various organizations		
7.	Bequest value	Donations by NGO and various organizations		
8.	Existence value	Contingent valuation method		
	Total			

Constraints of valuation methods

Valuation methods developed so far are not entirely able to capture the exact value of natural and environmental resources. Non- market products of nature, which are largely used by indigenous people, are difficult to be valued since there does not exist a market for these products. There does not exist a clear ranking of methods of valuation. All methods are not equally relevant for all resources. Each technique requires a variety of assumptions depending upon the method being applied and of course the resource being considered for valuation. There is an unresolved methodological puzzle that still remains and relates to the consistency of different valuation techniques.

Conclusion

It is neither possible nor sensible to conserve everything. Since development activities are necessary for the country's progress even at the cost of natural resources, a pertinent question is: how much resources should be conserved? Which should be considered first? How should conservation be linked to development? We need to understand what is driving the present loss of environmental resources and what may be done to conserve it.

The advantage of an economic approach to the valuation of resources is that it provides a means of quantifying error and also indicates how markets might be reformed to remove the current sources of biases, and where it is not possible to reform markets, how government might intervene to correct the signals to private resource users. It also indicates how and where economic activity may be constrained so as to protect resources that are important for maintaining the options open to future generations. The valuation of environmental resources are much more than just 'getting the prices right". So use of measurement is not to eliminate but to minimize adverse effects on environment.

Suggested Reading:

Dixit, A. M., Kumar, P., Kumar, L., Pathak, K.D. and Patel, M.I. (2010). Economic Valuation of Coral Reef Systems in Gulf of Kachchh. Final Report. World Bank aided Integrated Coastal Zone Management (ICZM) Project. Submitted to Gujarat Ecology Commission. 158 pp.

13

ASSESSING THE FINANCIAL VIABILITY / PERFORMANCE OF BUSINESS

Shyam S. Salim and Reeja Fernandez

Meaning and Definition

Financial performance is a subjective measure of how well a firm can use assets from its primary mode of business and generate revenues. This term is also used as a general measure of a firm's overall financial health over a given period of time, and can be used to compare similar firms across the same industry or sectors.

Financial statements for businesses usually include income statements, balance sheets, and cash flows. Financial statement analysis is the process of reviewing and evaluating a company's financial statements (such as the balance sheet or profit and loss statement), thereby gaining an understanding of the financial health of the company and enabling more effective decision making.

The balance sheet is a snapshot showing what is owned and owed at a single moment. It provides an overview of how well the company is managing assets and liabilities. The income statement provides a summary of operations for the entire year which starts with sales or revenue and ends with net income. The cash flow statement is a combination of both the income statement and the balance sheet.

Practical utility

- Help to identify trends by comparing ratios across multiple time periods and statement types
- This helps to measure liquidity, profitability, company-wide efficiency and cash flow.
- This is important for all companies with different scale of operations which help to project the financial health of the company.
- The cash flow analysis provides financial information in assessing the selected enterprises/ activity group's liquidity, the quality of earnings and solvency.
- The income statement can be used to calculate a number of metrics, including the gross profit margin, the operating profit margin, the net profit margin and the operating ratio.
- It is a valuable tool to monitor operations. Together with the balance sheet and cash flow statement, the income statement provides an in-depth look at a company's financial performance and position.

Key words:

Cash Inflow, Cash Outflow, income statement, profit and loss statement, Net worth, balance sheet.

Data requirement and software support:

The cash flow statement utilizes monthly data on revenue generation which includes cash sales, credit sales, interest accrued, advances received, and other inflows and all the outflows like operating expenses, tax payments, loan repayments are collected. The ending cash balance can be calculated by summarizing all the monthly cash values. The monthly data set is combined in an Excel sheet in which we can easily calculate the financial statement for the year. An income statement uses data on revenues/ gains and expenses/losses.

The money earned from the primary and secondary activities and the gains received from the appreciation of assets etc are needed for calculating the profit statement and the losses incurred from the primary and the secondary activities and the monetary losses due to depreciation of assets are included in the loss statement. The balance sheet utilizes the assets and liabilities of the company segregated as current assets, intermediate assets and long term assets and liabilities as current liabilities, intermediate liabilities and long term liabilities. The net worth statement is assessed mainly on quarterly or yearly basis based on the quantum of business.

A. Cash Flow Statement

A statement of cash flows is a financial statement which summarizes cash transactions of a business units/ enterprise's during a given accounting period (usually 1 year) and classifies them under cash inflows and cash outflows which shows how cash moved during the period. The cash flow statements can be segregated as cash flows from operating, investing and financing activities which helps to analyze the revenue gains and losses in the activities of the group. The cash flow analysis is done on a monthly basis.

- ❖ Cash inflow - cash sales, receivables, credit sales, loans as well as equity.
- ❖ Cash outflow - cash expenditure, tax payments and loan repayments.

Sample of a cash flow budget

Sl No	Particulars	J	F	M	A	M	J	J	A	S	O	N	D
1.	Cash Inflows												
	Cash balance												
	Credit sales												
	Cash sales												
	Other cash inflow												
	Total												
2.	Cash outflows												
	Operating expenditure												
	Loan repayment												
	Tax payments												
	Total												
3.	Cash available												
	New borrowing												
	Interest												
	Depreciation												
4	Ending cash balance												

Worked out example:

A tentative cash flow statement of "Abhaya garment and textiles "Theeramythri activity group which is funded by Society for Assistance to Fisherwomen is given below for the year 2016.

MONTH			J	F	M	A	M	J	J	A	S	O	N	D
Cash Inflow	Cash sales		10000	15600	12680	18500	12500	25650	18650	22960	19360	15640	18960	14680
	Credit sales		2880	2000	1500	800	900	500	3500	1200	9450	850	600	580
	Interest accrued		1000				1000				1000			1000
	Advance		2500					5000	3500		4000			
	Loans- banks, revolving fund, others		10000											25000
	Contribution by members		5000	1000				4000				3000		
	Other assistance from SAF								10000					
	New investment													
	Others		800	3800	4000	2550	3950	8500	5210	9850	1590	6780	1000	2050
Total			**32180**	**22400**	**18180**	**21850**	**18350**	**43650**	**40860**	**34010**	**35400**	**26270**	**20560**	**43310**
Cash Outflow	Operating Expenditure	Rent	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
		Water charges	200	250	300	200	200	200	200	200	250	200	200	200
		Electricity charges	1500	1800	1600	1500	1400	1500	1650	1860	1620	1540	1280	1200
		Transportation cost	1000	1000	850	1500	1000	1500	1500	2500	2000	1000	2000	1000
		Purchase of raw materials	5000				10000	1000	5000	4000			4000	
		Packing material												
		Payment for credit purchase	500											
		Maintenance charges / Service charges												
	Labour Component	No of man days	26*3											
		Wages	15000	15000	15000	15000	15000	24000	15000	24000	15000	15000	15000	15000
		Profit sharing	0			1500			3000					3000
	Loan Component	Bank loan repayment												
		Interest on loan		1000				1000		1000		1000		
		Revolving fund repayment	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
		Loan to members			6000									
	Other Outflows	License fee												
		Taxes												
		Fixed procurement							10000					
		Others	500	100	200	800	1000	850	200	150	600	850	100	250
Total			**25700**	**21150**	**25950**	**22500**	**30600**	**32050**	**38550**	**35710**	**21470**	**21590**	**24580**	**22650**
Ending cash balance(Total Inflow- Total Outflow)			**6480**	**1250**	**-7770**	**-650**	**-12250**	**11600**	**2310**	**-1700**	**13930**	**4680**	**-4020**	**20660**

Inferences:

The financial statement for the year 2016= Total cash inflow - Total cash outflow

Ending balance for the year 2016 =Rs. 34,520**.**

If the cash from operating activities is consistently greater than the net income, the company's net income or earnings are said to be of a "high quality". When the cash outflows during a period are higher than the cash inflows during the same period there is a negative cash flow.

B. Income Statement/ Profit or Loss Statement

An Income statement or profit and loss statement (P&L) is a financial statement that summarizes the revenues, costs and expenses incurred during a specific period of time, usually a fiscal quarter or year. These records provide information about the enterprise's ability – or lack thereof – to generate profit by increasing revenue, reducing costs, or both. The P&L statement is also referred to as "statement of profit and loss", "income statement," "statement of operations," "statement of financial results," and "income and expense statement."

Souhridha Poultry and Fish Farm Group Income Statement
For Five months ended May 31st 2016

Particulars	Amount (in Rs.)
I. **Receipts**	
A. ***Returns from the sale of fish***	57,000
B. Revenue from poultry	8,000
C. Revenue from other enterprises	12,000
D. Gifts	2,000
E. Appreciation in the value of assets	3,000
Gross Income(GI)	**82,000**
II. **Expenses**	
A. **Operating expenses or costs**	
(i) Hired human labour	10,500
(ii) Machine labour	1,500
(iii) Seed	1,100
(iv) Feed	5,000
(v) Manures and Fertilizers	3,000
(vi) Veterinary aid	500
(vii) Irrigation	1,000
(viii) Miscellaneous	2,000
(ix) Interest on working capital	2,100
Total Operating Cost(TOC)	**26,700**
B. **Fixed expenses or costs**	
(i) Depreciation	3,000
(ii) Land revenue	200
(ii) Interest on fixed capital	3,200
(iii) Rental value of owned land	10,000
Total fixed cost(TFC)	**16,400**
III. **Net cash income (NCI)**	79,000 - 26,700 = **Rs.52, 300**
IV. **Net operating income (NOI)**	82,000 - 26,700 = **Rs.55, 300**
V. **Net farm income (NFI)**	55,300 - 16,400 = **Rs.38, 900**

Inferences:

Net income= Revenue- Expenses

Net income is the bottom line and Revenue and expenses are the top line.

Net profit = Percentage of sales after deducting all expenses and overheads.

C. Balance Sheet/ Net worth Statement

The balance sheet shows the financial condition and stability of the business at a particular point of time.It gives an account of the total assets and liabilities.The snapshot of balance sheet indicate the net worth or net defecit of the enterprise.

❖ Assets include
  - Current assets (12 months)
  - Intermediate assets (1-10 years)
  - Fixed or long term assets (more than 10 years)

❖ Liabilities include
  - Current liabilities (12 months)
  - Intermediate liabilities (1-10 years)
  - Fixed or long term liabilities (more than 10 years)

Format of Net Worth Statement

Sl.No.	Liabilities (A)(Rs.)	Assets (B)(Rs.)
1.		
2.		
3.		
Total =		Total =
Networth (B - A) =		

Worked out Example: The net worth statement of a Food Self help groups.

Liabilities (A)			Assets (B)	
1. Current			**Current**	
Short term loans :			Cash in bank	8,000
Hand loans	2,000		Cash on hand	9,000
Revolving fund	25000		Account receivable	12,000
Sub-total	27,000		Sub-total	29,000
2. Intermediate		**Intermediate**		
Loans on machinery and equipments	10,000		Machinery and and equipments	50,000
Loans on purchase of stock	6,000		Stock	15000
Sub-total	16,000		Sub-total	65,000
3. Long term (fixed)	**Long term (fixed)**			
Nil	-		Building (shop)	
Sub-total	-		Sub-total	
Total liabilities		**43000**	**Total assets**	**94000**

Inferences

Solvency Ratios

❖ *Quick ratios=(Current Assets- Inventories)/ Current liablities*

The quick ratio measures a company's ability to meet its short-term obligations with its most liquid assets. The higher the quick ratio, the better the position of the company.

❖ *Current Ratio = Current Assets / Current Liabilities*

This is used to determine the company's ability to pay back its short term liabilities. If the ratio is below 1, it raises a warning sign as to whether the company is able to pay its short term obligations when due.

❖ ***Debt/Equity Ratios***

Total Debt/Equity Ratio = Total Liabilities / Shareholders Equity

Long Term Debt/Equity Ratio = Long Term Debt / Shareholders Equity

Short Term Debt/Equity Ratio = Short Term Debt / Shareholders Equity

A high ratio means that the company has been growing due to debt.

Activity Ratios

Activity financial ratios measure how well a company is able to convert its assets in the balance sheet into cash or sales.

❖ *Days Sales Outstanding (DSO)= (Receivables / Revenue) x 365*

A low DSO number means that it takes a company fewer days to collect its accounts receivable. A high DSO number shows that a company is selling its product to customers on credit and taking longer to collect money.

❖ *Days Inventory Outstanding = (Inventory / COGS) x 365*

This financial ratio is used to measure the average number of days a company holds inventory before selling it.

❖ *Days Payable Outstanding = (Accounts Payable / COGS) x 365*

Days Payable Outstanding shows the time in days a business has to pay back its creditors. On the flip side, it also shows how long the company can utilize the cash before paying it back.

❖ *Cash Conversion Cycle = DIO + DSO – DPO*

The entire cash conversion cycle is a measure of management effectiveness. The lower the better and a great way to compare competitors.

Turnover Ratios

❖ **Receivables Turnover = Revenue / Average Accounts Receivables**

The receivables turnover ratio is one that is categorized as an activity ratio because it measures the company's effectiveness in collecting its credit sales.

❖ *Inventory Turnover = COGS / Average of Inventory*

Inventory turnover is important for companies with physical products and is best used to compare against peers.

- *Average Age of Inventory (days)= Average of Inventory / Revenue*

  Average age of inventory is just the inverse of Inventory Turnover.

- ***Inventory to Sales Ratio***

  Inventory to Sales = Inventory / Revenue

  The objective is to see how inventory is being managed as it will signal potential problems with cash flow. An increase in the inventory to sales ratio can indicate that

- The investment in inventory is growing more rapidly than sales
- The sales are dropping

  Vice versa, if the inventory to sales ratio drops, it could mean that

- The investment in inventory is shrinking in relation to sales
- The sales are increasing

Debt to Equity Ratios

These ratios have trended in order to understand whether the company is in a difficult situation or not. If a company operates on high leverage and has maintained a high debt ratio, it is not as alarming as a company with a low debt ratio suddenly showing a spike in the debt ratio.

- *LT-Debt to Total Debt = Long Term Debt / Total Debt*

  The long term debt ratio is an indicator that the company does not have enough cash to run future operations.

- *ST-Debt to Total Debt = Short Term Debt / Total Debt*

  If the short term debt ratio is high, this is a big warning sign. The debt payment is coming due and has to be re-negotiated or paid off with a new loan.

- *Total Liabilities to Total Assets = Total Liabilities / Total Assets*
- *Price to Working Capital = Price / Working Capital per Share, where Working Capital = Current Assets – Current Liabilities*

  A high working capital ratio shows whether the business can continue to operate without troubles.

Suggested Readings

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14

ASSESSING VULNERABILITY OF COASTAL HOUSEHOLDS

Shyam S. Salim and Remya R.

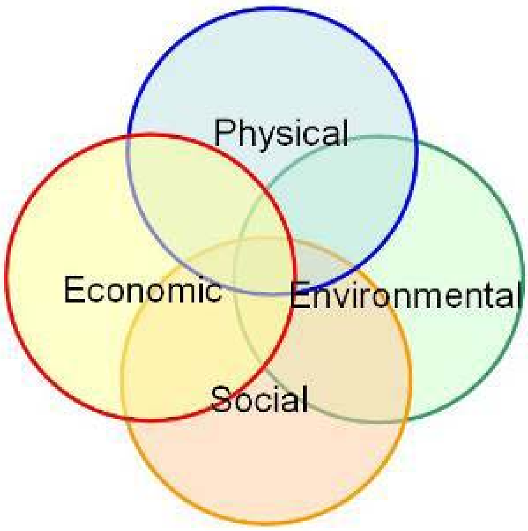
Definition

According to Intergovernmental Panel on Climate Change (IPCC), vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed; its sensitivity; and adaptive capacity (IPCC, 2001). Vulnerability assessment is the analysis of the expected impacts, risks and the adaptive capacity of a region or sector to the effects of climate change. A vulnerability index is a composite of multiple quantitative indicators that via some formula, delivers a single numerical result.

Theoretical back ground

Vulnerability is

- multi-dimensional (e.g. physical, social, economic, environmental, institutional, and human factors define vulnerability);
- dynamic i.e. vulnerability changes over time;
- scale-dependent (vulnerability can be expressed at different scales from human to household to community to country resolution)
- site-specific



Exposure (E), Sensitivity (S) and Adaptive Capacity (AC) are the key factors that determine the vulnerability of households and communities to the impacts of climate variability and change (IPCC 2007). Indicators for each of these factors are therefore essential elements of a comprehensive vulnerability. Exposure is the direct danger (i.e., the stressor), and the nature and extent of changes to a region's climate variables (e.g., temperature, precipitation, extreme weather events). Sensitivity describes the human-environmental conditions that can worsen the hazard, ameliorate the hazard, or trigger an impact. Adaptive Capacity is the potential to implement adaptation measures that help avert potential impacts. The mean values of the three sub-indices of Exposure (E), Sensitivity (S), and Adaptive Capacity (AC) are combined to develop a composite vulnerability index by using the following additive (averaging) equation (Islam et al. 2014).

Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)

Practical Utility

The greater the exposure or sensitivity, the greater is the vulnerability, while the greater the adaptive capacity, the lesser is the vulnerability. Reducing vulnerability would involve reducing impact, or increasing adaptive capacity. Thus by adopting mitigation measures, a population vulnerable to climate change could be converted to a climate resilient community. A new framework titled 'CReVAMP' – "Climate Resilient Village Adaptation and Mitigation Plan" has been conceptualised for planning and implementing village level adaption and mitigation plan. CReVAMP is developed to identify existing climate adaptation and mitigation- probing alternatives and their trade-offs, sensitizing and improving the resilience of community towards climate change and initiating a multi stakeholders platform for developing a climate knowledge and information systems. This kind of bottom up approach would help the climatologists and policy makers to implement climate adaptation plans for the district, state and finally for the country (Shyam *et al.,* 2014).

Key words

Vulnerability, exposure, sensitivity, Adaptive Capacity, mitigation, resilient, CReVAMP, bottom up approach

Software support

The data can be tabulated in MS-excel. However, it may also be computed in software such as R, SPSS etc.

Data requirement

After selecting the study area which consists of several regions, a set of indicators are selected for each of the three component of vulnerability. A list of possible indicators is provided in the Annexure 1. The indicators can be selected based the availability of data, personal judgement or previous research. Since vulnerability is dynamic over time, it is important that all the indicators relate to the particular year chosen. If vulnerability has to be assessed over years then the data for each year for all the indicators in each region must be collected.

Methodology

1 *Data collection*

Construction of vulnerability index consists of several steps.

- ❖ First of all, a pilot study should be conducted to identify the coastal districts most vulnerable to a natural disaster within a state. After identifying the districts, the villages within the districts have to be earmarked for carrying out the study using Iyengar and Sudarshan method (1982).
- ❖ The second step is to classify the households from the selected villages. The data can be collected using a multi-method approach by employing stratified random sampling technique. Sensitivity, adaptive capacity and exposure data are collected using household questionnaires by identified / trained enumerators. Inorder to assess vulnerability at household level, the ward details of each study area has to be collected.
- ❖ Thirdly, local self-governments of each district involved in the study educated local people for further training, prior to the implementation of survey.

- In the fourth step, these selected people were trained in topics covering climate change, vulnerability, sensitivity, exposure, adaptive capacity and resource management. They were also specifically trained in conducting household surveys among fishers.

2 *Data Analysis*

The data collection aimed at identifying the extent of vulnerability as well as the component structure of vulnerability category measured by items with a Likert-type response scale and to summarize the data contained in numerous items into one or more subscales of vulnerability category that can be used in further models. A composite vulnerability index approach was used in this study to evaluate relative exposure, sensitivity, and adaptive capacity (Islam et al. 2014). A composite index approach calculates vulnerability indices using aggregate data for a set of indicators. Using the set of indicators the vulnerability of fishery based livelihood systems using the combination of individual indicator was quantitatively assessed. Since each indicator was measured on a different scale, they were normalised (rescaled from 0 to 1) by using the following equations

$$x_{ij} = \frac{X_{ij} - \min_i \{X_{ij}\}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}}$$; if x_{ij} increases with vulnerability…………….. (i)

$$y_{ij} = \frac{\max_i \{X_{ij}\} - X_{ij}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}}$$; if y_{ij} decreases with vulnerability……………(ii)

Where, x_{ij} and y_{ij} are the variables representing effects on the vulnerability indices. The values after normalisation are transformed into a four point Likert scale, categorised as 0-0.25, 0.26-.5, 0.6-0.75 and 0.76-1 which are assigned score values 1 (low), 2 (moderate), 3 (high) and 4 (very high) respectively. The mean values of the three sub-indices of Exposure (E), Sensitivity (S), and Adaptive Capacity (AC) were combined to develop a composite vulnerability index (V) by using the following additive (averaging) equation (Islam et al. 2014).

Vulnerability (V) = Exposure (E) + Sensitivity (S) - Adaptive Capacity (AC)

Thus, the overall vulnerability index was calculated each for the regions and the computation was attempted to arrive at vulnerability indices at household level. Respondents households were asked to opine responses referring to their knowledge on degree of vulnerability related to various aspects of climate change, livelihood and adaptation and mitigation options etc. Different components were identified under various categories like Exposure, Sensitivity and Adaptive capacity which were found to influence the overall vulnerability of the coastal population of both the study areas (Annexure –I).

Worked out example

The example for assessing vulnerability of coastal households has been taken from the GULLS (Global Understanding for Local Learning Solutions) project, which focuses on determining the social vulnerability of coastal communities in the hotspot countries of Southern hemisphere. In the present study, Poonthura village of Thiruvananthapuram district from the south west hotspot region is selected. The study determined the scope of developing village level adaptation and mitigation plan for the community through a comprehensive analysis of the community perception on climate change impacts, vulnerability and existing adaptation mitigation strategies.

Within the communities we targeted fishery-dependent households, which constituted 500 households from Poonthura. The data was collected during 2014 using a multi-method approach. A stratified random sampling technique was followed to select response households. Participants were mostly head of households or an adult member. The method of data collection was unique with initially, developing relationships and rapport with the local self-government officials (Panchayath), line departments and women self-help groups within the communities by regular visits and focussed group discussions. Secondly, local self-governments of each district involved in the study educated local people for further training, prior to the implementation of survey. Thirdly, these selected people were trained in topics covering climate change, vulnerability, sensitivity, exposure, adaptive capacity and resource management. They were also specifically trained in conducting household surveys among fishers. Face to face interviews was conducted at household level which almost consumed an hour. Periodic monitoring and evaluation was done followed by a sensitisation workshop for the two study regions. In order to assess vulnerability at household level, the ward details of study area was collected. Poonthura village consisted of two coastal wards from where data was collected.

Out of the numerous indicators mentioned in Annexure 1, those respective to sensitivity, exposure and adaptive capacity were appropriately categorised. For each component of vulnerability, the collected data are then arranged in the form of a rectangular matrix with rows representing regions and columns representing indicators. Let there be M regions/districts and let us say we have collected K indicators. Let *Xij* be the value of the indicator *j* corresponding to region *i.* It should be noted that this type of arrangement of data is usually done in statistical analysis of survey data. Obviously the indicators will be in different units and scales. The methodology used in United Nations Development Programme (UNDP)'s Human Development Index (HDI) (UNDP, 2006) is followed to normalize them. That is, in order to obtain figures which are free from the units and also to standardize their values, first they are normalized so that they all lie between 0 and 1. Before doing this, it is important to identify the functional relationship between the indicators and vulnerability. Two types of functional relationship are possible: vulnerability increases with increase (decrease) in the value of the indicator. Assume that higher the value of the indicator more is the vulnerability. It is clear that higher the values of these indicators more will be the vulnerability of the region to climate change as variation in climate variables increase the vulnerability. In this case we say that the variables have ↑ functional relationship with vulnerability and the normalization is done using the formula

$$x_{ij} = \frac{X_{ij} - \min_i \left\{ X_{ij} \right\}}{\max_i \left\{ X_{ij} \right\} - \min_i \left\{ X_{ij} \right\}}$$

It is clear that all these scores will lie between 0 and 1. The value 1 will correspond to that

region with maximum value and 0 will correspond to the region with minimum value. The values after normalisation were transformed into a four point Likert scale, categorised as 0-0.25, 0.26-.5, 0.6-0.75 and 0.76-1 which are assigned score values 1 (low), 2 (moderate), 3 (high) and 4 (very high) respectively. Thus, by doing the step by step analysis mentioned above, the results of Vulnerability of Poonthura village is represented in the table.

Vulnerability of Poonthura fishing village

Locations	Exposure	Sensitivity	Adaptive Capacity	Vulnerability
Poonthura	2.80	2.57	2.52	2.85

Interpretation of results

The overall vulnerability values indicate that Poonthura village is moderately vulnerable to climate change. The proximity of Poonthura village to the sea can be attributed as the major factor contributing the increase in vulnerability. In addition higher exposure on account of environmental changes, occurrence of drought and shoreline changes is also attributed to higher vulnerability in Poonthura. The adaptive capacity of the village is low when compared to exposure and sensitivity values, indicating the urgent need for developing appropriate adaptive interventions.

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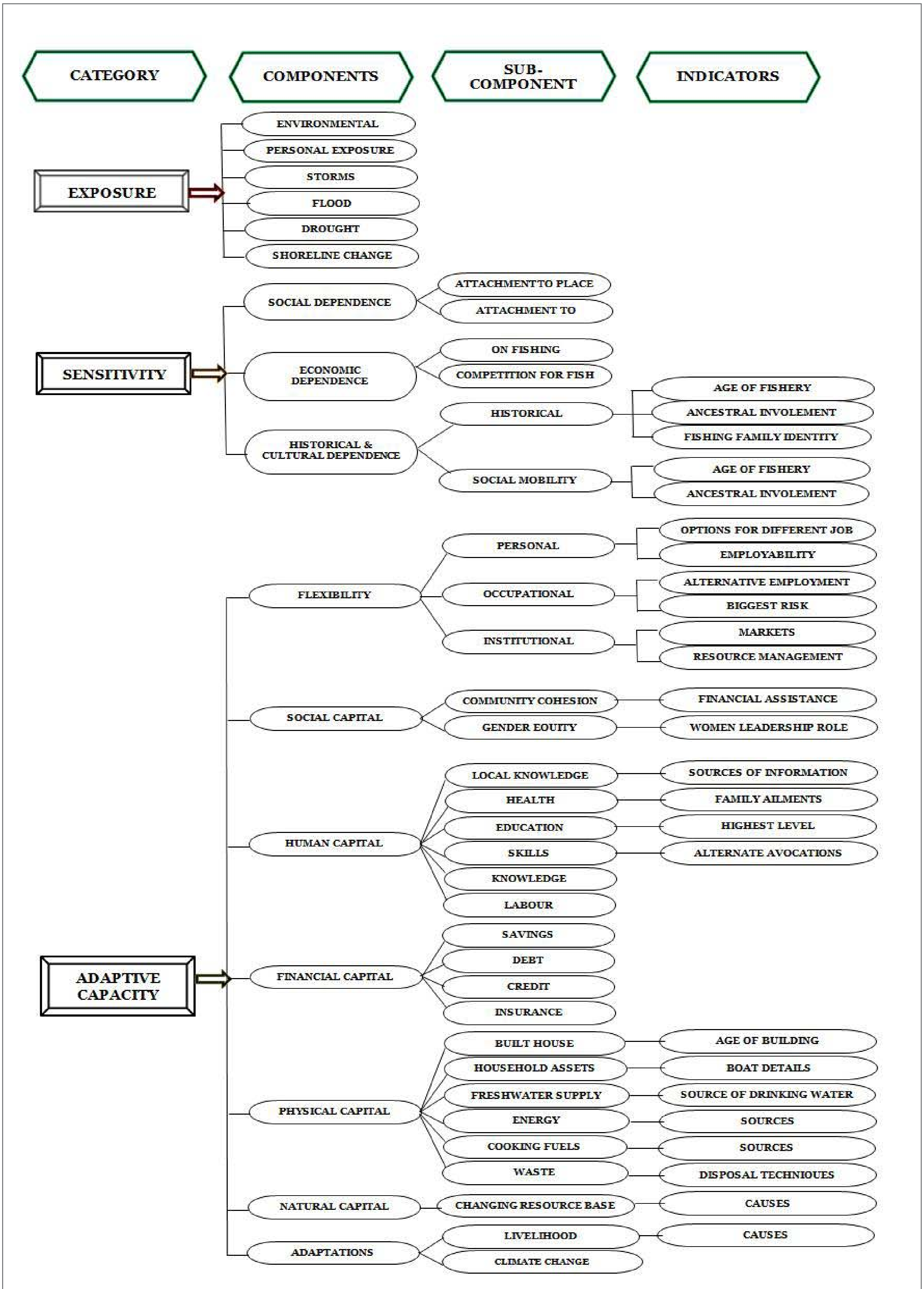
Annexure-1


CATEGORY
COMPONENTS
SUB-COMPONENT
INDICATORS
EXPOSURE
ENVIRONMENTAL
PERSONAL EXPOSURE
STORMS
FLOOD
DROUGHT
SHORELINE CHANGE
SENSITIVITY
SOCIAL DEPENDENCE
ATTACHMENTTO PLACE
ATTACHMENT TO
ECONOMIC DEPENDENCE
ON FISHING
COMPETITION FOR FISH
HISTORICAL & CULTURAL DEPENDENCE
HISTORICAL
AGE OF FISHERY
ANCESTRAL INVOLEMENT
FISHING FAMILY IDENTITY
SOCIAL MOBILITY
AGE OF FISHERY
ANCESTRAL INVOLEMENT
ADAPTIVE CAPACITY
FLEXIBILITY
PERSONAL
OPTIONS FOR DIFFERENT JOB
EMPLOYABILITY
OCCUPATIONAL
ALTERNATIVE EMPLOYMENT
BIGGEST RISK
INSTITUTIONAL
MARKETS
RESOURCE MANAGEMENT
SOCIAL CAPITAL
COMMUNITY COHESION
FINANCIAL ASSISTANCE
GENDER EQUITY
WOMEN LEADERSHIP ROLE
HUMAN CAPITAL
LOCAL KNOWLEDGE
SOURCES OF INFORMATION
HEALTH
FAMILY AILMENTS
EDUCATION
HIGHEST LEVEL
SKILLS
ALTERNATE AVOCATIONS
KNOWLEDGE
LABOUR
FINANCIAL CAPITAL
SAVINGS
DEBT
CREDIT
INSURANCE
PHYSICAL CAPITAL
BUILT HOUSE
AGE OF BUILDING
HOUSEHOLD ASSETS
BOAT DETAILS
FRESHWATER SUPPLY
SOURCE OF DRINKING WATER
ENERGY
SOURCES
COOKING FUELS
SOURCES
WASTE
DISPOSAL TECHNIQUES
NATURAL CAPITAL
CHANGING RESOURCE BASE
CAUSES
ADAPTATIONS
LIVELIHOOD
CAUSES
CLIMATE CHANGE

15

DECISION MAKING IN OPTIMAL PRODUCTION ACROSS FARM / FIRMS

Shyam S. Salim and Ramees Rahman M.

Often, producing fish and fish products require judicious decision making on how much to produce with the given constraints of resource, capital and time. The decision making in optimal production depend mostly on the cost of resources and price of the output. The production cost includes fixed and variable costs and determining the financial viability of a fish farm or firm (a processing plant) can be discerned through break-even analysis. Break-even analysis technique is used widely in production managements to determine how much production volume is needed to start making a profit.

Basic Cost Concepts

Cost can be defined as the expenditure incurred on the production of a good or service. Total cost (TC) incurred for the production can be divided into Fixed Cost (FC) and Variable Cost (VC).

Total Cost = Fixed Cost + Variable Cost

Fixed cost: Incurred for fixed assets such as land, building, machineries etc. which does not change with the level of output. Rent, depreciation, research and development, marketing costs, administration costs etc. can be cited as examples for fixed costs.

Variable cost or operating cost: Disbursed for the raw materials, wages of labour, etc. which changes with level of production. Variable cost varies directly with the level of output.

Average Costs (AC) is the cost of producing one unit of the output and is determined as follows

AC = TC/Q, Where 'Q' is the total level of output.

Or AC = AFC + AVC,

Where AFC is average fixed cost and AVC is average variable cost.

Average Variable Cost (AVC): Variable cost for producing one unit of output. As production increases, AVC decreases in the initial stage and after a particular point (when MP=0) increases.

AVC = TVC/Q, Where TVC is the total variable cost.

Average Fixed Cost (AFC): Fixed cost required to produce one unit of the output. AFC decreases with increasing output.

AFC = TFC/Q, Where TFC is the total fixed cost.

Marginal Cost (MC): Addition made to total cost as a result of producing one additional unit of the product.

MC = $\frac{\Delta TC}{\Delta Q}$, where ΔTC is change in total cost

ΔQ is change in output

Break-Even Point (BEP)

Break-even point analysis is one of the simplest ways used to highlight areas of economic strength and weakness in a firm. Being one of the main tools of the cost-volume profit (CVP) analysis, it assists in finding out the ways to enhance profitability. The equality point of total cost and total revenue is termed as break-even point. It is the no-profit zone which represents the quantity or revenue required to cover total costs.

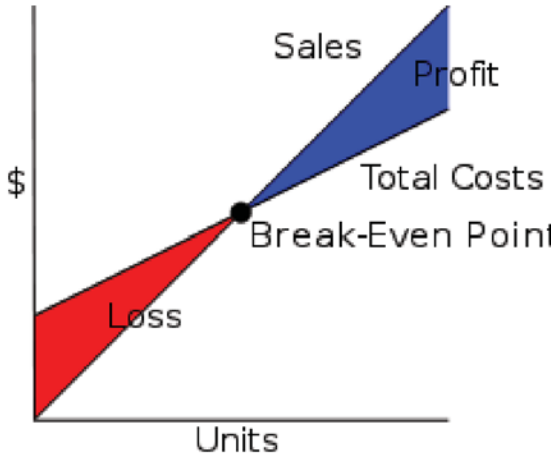


Fig 1: Break-even chart

The break-even chart depicted in figure 1 is a graphical representation of cost at various levels of production where, the break-even point is the neither profit nor loss zone represented by the intersection of the two lines.

Theoretical Background

Major decisions related to safety margin, target profit, sales promotion etc. can be taken by using Break even analysis. The analysis ascertains the extent to which the firm/farm can afford to decline in sales/ production, before it starts incurring losses. The analysis is mainly used to fix the optimum volume of production which could provide increased volume of sales, increased selling price, reduced variable expenses per unit and reduced fixed costs.

Major advantages of BEP analysis can be pointed out as follows;

Profitability: Useful in understanding the relationship between fixed cost, variable cost and the level of profitability at various levels of sales.

Production / Sales level: Analysis is suitable to calculate the volume of production / sales necessary to achieve a maximize profit/ minimize loses . It provides the farm/ business with a minimum production/ sales level which the farm/ firm needs to achieve to avoid losses.

Break-even Quantity (BEQ) determines the quantity required to cover fixed costs. BEV = Fixed costs/ (revenue per unit – variable cost per unit) = Fixed cost/ Unit margin.

Computation Techniques - Algebraic Method:

BEP in Units: BEP (Qty) = F/ (P-V),

Where F= Fixed cost in Rs.
P = Price per unit of the product
V = Variable cost per unit of the product

BEP in monetary value: BEP = F/ (1-(V/P))

Margin of Safety (MoS)

The margin between the actual/budgeted sales and breakeven point is termed as margin of safety. It is the difference between total output and output at BEP. Margin of Safety measures risk while BEP is a measure of sustenance. Breakeven quantity at lower level is desirable while Margin of Safety is better for a business.

Margin of Safety = Total Output – Output at BEP

= Total Revenue – Revenue at BEP

Percentage margin of safety (Qty) = BEP output / Volume of output * 100

Percentage margin of safety (In money) = BEP in monetary value/ Total revenue * 100

Example:

Estimate the profits of two fish processing plants.

Sl.No.	Fixed Cost (lakhs)	Variable Cost (lakhs)	Total Cost (lakhs)	Price per ton (lakhs)	Volume of Output (Qty in ton)	Total Revenue (lakhs)	Variable Cost Fund (lakhs)
Plant I	120	125	245	3.00	120	360	1.041
Plant II	90	135	225	3.00	100	300	1.35

Plant 1:

BEP (Qty) $= \frac{F}{(P-V)}$

$= \frac{120}{(3.00-1.04)}$

= 61.28

BEP (Monetary Value) $= \frac{F}{(1-\frac{V}{P})}$

$= \frac{120}{(1-\frac{1.04}{3.00})}$

= 40.56 lakhs

Margin of Safety = Total Output – Output at BEP

= 120 – 61.28

= 58.72

Percentage margin of safety (Qty) = $\frac{\text{BEP Output}}{\text{Volume of output}}$ X 100

$= \frac{61.28}{3600}$ X100

= 51.06 percent

Percentage margin of safety (In money) = $\frac{\text{BEP in monetary value}}{\text{Total revenue}}$ X 100

$= \frac{40.56}{360} \text{ X } 100$

= 11.27 percent

Plant 2:

BEP (Qty) = $\frac{F}{(P-V)}$

$= \frac{90}{(3.00-1.35)}$

= 54.55

BEP (Monetary Value) = $\frac{F}{(1-\frac{V}{P})}$

$= \frac{90}{(1-\frac{1.35}{3.00})}$

= 33.96 lakhs

Margin of Safety = Total Output – Output at BEP

= 100 – 54.55

= 45.45

Percentage margin of safety (Qty) = $\frac{\text{BEP Output}}{\text{Volume of output}} \text{ X } 100$

$= \frac{54.55}{100} \text{ X}100$

= 54.55 percent

Percentage margin of safety (In money) = $\frac{\text{BEP in monetary value}}{\text{Total revenue}} \text{ X } 100$

$= \frac{33.96}{300} \text{ X } 100$

= 11.32 percent

Interpretation

Between the two fish processing plants analyzed, it was found that Plant II had a lesser breakeven quantity when compared to Plant I with higher the margin of safety and higher break even points in terms of monetary value.

Breakeven quantity is desirable at a lower level for the betterment of the firm. BEP provides a minimum production/ sales level which the farms/ firm needs to achieve to avoid losses. Whereas margin of safety is desired at a higher level since it represents the shock absorbing capacity of the farm/ firm in the event of unexpected risks and uncertainties and also allows the farm/ firm to undertake diversify production / sales promotion activities. BEP assists a farm/ firm in taking production decisions and also considers the impact of revenue/ sales in profitability.

16

ASSESSING THE CONSUMER PREFERENCES USING CONJOINT ANALYSIS: AN APPLICATION IN FISHERIES SECTOR

Shyam S. Salim and Athira N.R.

Fish has become an indispensable part in the food basket as it is considered as a healthy food which is rich in edible protein. It is a source of cheap and nutritious food assuring good food security. Day by day, fish consumption level is increasing nevertheless there exists a wide variance among the buyers for fish. There are some attributes and preferences in buying fish which makes a perfect fish consumption pattern and trends among the consumers. Conjoint analysis is one such technique which enables to understand the factors that drives people to consume and buy fish. It analyses the underlined phenomena of choosing a rational decision of the consumers in fish consumption.

Definition

Conjoint analysis is a survey based statistical technique used in market research that helps determine how people value different attributes (feature, function, benefits) that make up an individual product or service. Its purpose is to determine how people perceive and value different features or attributes of a particular product or service.

Theoretical back ground

Conjoint analysis mainly consists of three fundamental processes. First of these is defining the ideal product features set, which provides the consumer with maximum utility. Second is determining the level of relationship between combinations of the product. Third is usage after the market margin simulation, profitability analyses and segmentation analysis. The starting point of conjoint analysis relies on total utility theory, according to which it can be said that total utility is a function of the price utility and quality utility.

Two different calculation methods are used in the conjoint analysis in order to determine the significance levels of the product characteristics. First of them is the determination of the differences between partial utility values (part-worth values) of every feature. In partial utility model, every feature level of the product is free from each other feature level partial benefits constitute the total utility of the consumer. General consumer evaluation on the product or service and thus, contribution of every characteristic to his preference is determined by partial utility (part-worth). Part-worth contribution model (additive part-worth), which is used widespread in the conjoint analysis can be explained as follows (Manly, 1995):

Prefijkl = ai + bj + ck + dl

Where,

$Pref_{ijk}$	=	Consumer preference or total utility
a_i	=	Product A feature part-worth in level i
b_j	=	Product B feature part-worth in level j
c_k	=	Product C feature part-worth in level k
d_l	=	Product D feature part-worth in level l is expressed so

In this study, the full concept method was chosen for the collection of data that is evaluated in the conjoint analysis. Accordingly, question cards are prepared for every feature level and are provided to consumers, which include features that are determined regarding the product and level of every feature. Thus, the degree of participation of consumers to every alternative and the level of perception for each alternative are determined.

Practical Utility

Conjoint analysis uses "derived importance" values for each attribute or feature. They are extensively used for a variety of purposes in economics, business management, consumption patterns, personnel and financial matters etc. In fisheries sector, conjoint analysis provides an insight on assessing the trends and pattern in buying fish, fish consumption behaviour, estimating the demands of different fisheries etc. Moreover, studies to the assess the attitude of the consumers preference and willingness to pay for the different value added products can also be measured using this technique.It also enables to use the results in developing market simulation models that can be used well into the future.

Data requirement

The data related to the preferences in buying different species of fish traded across the different markets of a particular place with its different attributes such as price/quality/freshness/source of purchase/ characteristics of purchase place etc.

Worked out example

Given below is a problem undertaken to assess the trends and pattern of fish consumption. The consumer's decision in buying fish is assessed with the different attributes of consumer's choice. The different attributes for buying fish and fish consumption are given as follows. The highest preference in buying fish is calculated using conjoint analysis and their inferences are given below.

Attributes	Factors
Drivers for buying fish	Price/ Affordability Availability Accessibility
Sources of Purchase	Landing Centre Retail Market
Features of purchase centres	Distance Freshness Variety of species

A full-factorial design includes all possible combinations of these attributes. There are 18 possible product concepts or cards that can be created from these three attributes:

3 drivers for buying fish × 2 sources of purchase × 3 features of purchase centres = 18 cards

Further assume that respondents rate each of the 18 product concepts on a scale from 0 to 10, where 10 represents the highest degree of preference. Table 1 shows the conjoint experimental design. Here we use XLSTAT to analyse data from conjoint questionnaires to attain the corresponding inference of our problem. XLSTAT - Conjoint analysis uses experimental designs to select a number of profiles and allow interviewed people to make their rankings (Table 2)

Steps for Conjoint Analysis

1. Launch XLSTAT, click on the **CJT** icon and then click on **Designs for conjoint analysis**.
2. A dialog box will then appear. You can now enter the name of the analysis, the number of factors (four in our case) and the number of profiles to be generated (10).

3. In the **Factors** tab, activate the **select on a sheet** option and select the data in the Factors sheet. Do not select labels associated to each column.

4. In the **Output tab**, individual sheets are not activated since the use of these sheets is not necessary for the tutorial. In a comprehensive analysis though, they can be very useful in order to get the responses filled directly by respondents.

5. Click on **OK**, a new dialog box appears. This allows you to select a specific fractional factorial design or to optimize the design (D-optimal). Here, we used the **optimize** option.

6. Click the Optimize button, the calculations run and the results are displayed.

7. For the aim of this study, 15 individuals have been questioned about their preferences. The survey answers can be found in the CJT design sheet and the results of the analysis in the CJT Analysis sheet.

8. Once the conjoint design is filled with the responses, you are ready to run the analysis. One option is to click on the button **Run the analysis** which automatically launches the interface with loaded data.

9. Once you click on the **OK** button, the computations are performed and the results are displayed.

10. Averages are calculated and displayed on charts. These give an idea of the importance of each factor.

Table 1: Conjoint Experimental Design

Card	Drivers for buying fish	Purchase Centres	Features of purchase centres
1	Price/Affordability	Landing Centre	Distance
2	Price/Affordability	Landing Centre	Freshness
3	Price/Affordability	Landing Centre	Variety
4	Price/Affordability	Retail Market	Distance
5	Price/Affordability	Retail Market	Freshness
6	Price/Affordability	Retail Market	Variety
7	Accessibility	Landing Centre	Distance
8	Accessibility	Landing Centre	Freshness
9	Accessibility	Landing Centre	Variety
10	Accessibility	Retail Market	Distance
11	Accessibility	Retail Market	Freshness
12	Accessibility	Retail Market	Variety
13	Availability	Landing Centre	Distance
14	Availability	Landing Centre	Freshness
15	Availability	Landing Centre	Variety
16	Availability	Retail Market	Distance
17	Availability	Retail Market	Freshness
18	Availability	Retail Market	Variety

Table 2: Rank of Preference in buying fish

Card	Drivers for buying fish	Purchase Centres	Features of purchase centres	Rank of preference
1	1	1	1	5
2	1	1	2	5
3	1	1	3	0
4	1	2	1	8
5	1	2	2	5
6	1	2	3	2
7	2	1	1	7
8	2	1	2	5
9	2	1	3	3
10	2	2	1	9
11	2	2	2	6
12	2	2	3	5
13	3	1	1	10
14	3	1	2	7
15	3	1	3	5
16	3	2	1	9
17	3	2	2	7
18	3	2	3	6

Table 3: Partial utilities (Individual data)

Source	Ind 1	Ind 2	Ind 3	Ind 4	Ind 5	Ind 6	Ind 7	Ind 8	Ind 9	Ind 10	Ind 11	Ind 12	Ind 13	Ind 14	Ind 15	Average
Intercept	5.31	5.08	5.44	4.66	5.5	5.33	5.7	5.72	6.11	5.97	5.02	5.233	5.164	5.433	4.789	
drivers-price/ affordability	3.23	3.33	1.54	-3.25	2.33	2.66	2.56	-3.56	-3.56	1.54	2.66	1.22	1.54	3.33	3.33	1.26
drivers-Accessibility	-4.25	-2.03	1.54	1.12	2.36	3.45	-3.33	2.56	2.89	1.54	3.45	-1.22	1.54	-2.03	-2.03	0.370667
drivers-Availability	2.83	1.56	2.33	1.56	-4.56	5.42	4.85	2.8	-4.63	2.33	5.42	0.375	2.33	1.56	1.56	1.715667
Source of purchase-retail centre	1.22	1.504	1.882	2.089	0.251	0.945	1.619	0.591	1.501	0.015	0.566	1.958	0.633	2.33	1.156	1.217333
Source of purchase-landing centre	-1.22	-1.504	-1.882	-2.089	-0.251	-0.945	-1.619	-0.591	-1.501	-0.015	-0.566	-1.958	-0.633	-2.33	-1.156	-1.21733
Features of purchase centre-Distance	0.375	1.54	2.66	-2.03	1.22	-2.03	1.54	-3.25	1.22	-2.03	-2.03	1.54	1.56	-0.251	2.66	0.1796
Features of purchase centre-Freshness	-0.365	1.54	3.45	1.56	-1.22	1.56	1.54	1.12	-1.22	1.56	1.56	1.54	1.504	1.22	3.45	1.253267
Features of purchase centre-variety	0.365	2.33	5.42	1.156	0.375	2.33	2.33	1.56	0.375	1.156	2.33	2.33	-1.504	-1.22	5.42	1.6502

Table 4: Importance's (Individual data)

Source	Ind 1	Ind 2	Ind 3	Ind 4	Ind 5	Ind 6	Ind 7	Ind 8	Ind 9	Ind 10	Ind 11	Ind 12	Ind 13	Ind 14	Ind 15	Average
Drivers for buying fish	69.079	38.335	58	23.737	35.938	30.769	52.779	11.765	37.747	18.021	35.042	34.615	40.667	38.899	35.938	37.42207
Purchase Centres	13.813	31.915	30	30.303	42.552	51.282	29.952	57.353	33.487	56.974	6.15	38.462	33.269	31.743	42.552	35.32047
Features of purchase centre	17.108	29.75	12	45.96	21.51	17.949	17.269	30.882	28.766	25.005	58.808	26.923	26.064	29.358	21.51	27.25747

Table 5: Aggregated utilities

Card	Drivers for buying fish	Purchase Centres	Features of purchase centres	Utility score
1	Price/Affordability	Landing Centre	Distance	0.1153
2	Price/Affordability	Landing Centre	Freshness	0.1156
3	Price/Affordability	Landing Centre	Variety	0.2331
4	Price/Affordability	Retail Market	Distance	0.4003
5	Price/Affordability	Retail Market	Freshness	0.5112
6	Price/Affordability	Retail Market	Variety	0.5103
7	Accessibility	Landing Centre	Distance	0.1328
8	Accessibility	Landing Centre	Freshness	0.3312
9	Accessibility	Landing Centre	Variety	0.4545
10	Accessibility	Retail Market	Distance	0.2569
11	Accessibility	Retail Market	Freshness	0.2011
12	Accessibility	Retail Market	Variety	0.3013
13	Availability	Landing Centre	Distance	0.2213
14	Availability	Landing Centre	Freshness	0.4333
15	Availability	Landing Centre	Variety	0.2003
16	Availability	Retail Market	Distance	0.2136
17	Availability	Retail Market	Freshness	0.5656
18	Availability	Retail Market	Variety	0.4433

Table 5: Aggregated Importances

Drivers for buying fish	37.42
Purchase Centres	35.32
Features of purchase centre	27.26

Interpretation of results

Partial utilities or worth values of the combinations, which were designed in the scope of the conjoint analysis and total worth value is composed of sum of factor level scores. The combination, which has the highest total worth is defined as the product feature set providing the consumers with optimum utility. Feature set, which has the lowest total worth value, provides the consumers with minimum level of benefit. In other words, the factor and factor level having the highest total utility is preferred by consumers with priority. The combination, which has the lowest total utility value is the product set that consumers prefer least. The aggregate utilities and aggregate Importances point out the highest priority of the consumer's choice. The results interpret that the optimum fish quality set, which provides the consumers with optimum benefit is the variety of fish from the retail fish markets which are highly fresh and easily available. i.e., the study explored that the optimum fish quality set, which provides the consumers with optimum benefit is the variety of fish from the retail fish markets which are highly good quality and fresh as presented in table 5. The product feature set furnished in table 8 is scrutinized as the optimum fish quality set of the study area with the highest total worth utility score of 0.5656. Moreover the primary choice considered by the consumer in buying fish and in fish consumption are the different drivers such as price/affordability, accessibility, availability with a score of 37.42. All the other attributes have only a second or third choice of preference.

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17

MEASUREMENT OF TECHNICAL EFFICIENCY IN MARINE FISHING

Aswathy N., R. Narayanakumar and M.S. Madan

The economic efficiency in a production process is divided into two components. Technical efficiency and pricing / allocative efficiency. Allocative efficiency is the ability of a farm to use inputs in optimal proportions, given their respective prices. A farmer is said to be price efficient if he maximises the profit. Technical efficiency is the effectiveness with which a given set of inputs is used to produce an output. A firm is said to be technically efficient if a firm is producing the maximum output from the minimum quantity of inputs. It is the ratio between actual and technically maximum possible output at a given level of resources. Farrell (1951) defined the economic efficiency by the product of technical efficiency and allocative efficiency.

Methods of technical efficiency analysis

Several methods are used to measure technical efficiency. The parametric approach consists of many econometrical techniques and non-econometrical ones estimating the production or cost frontier parameters (Cobb-Douglass, CES, Translog, etc.). The non-parametric approach is used when the production process cannot be identified by a functional form. Data Envelopment Analysis (DEA) helps to estimate the parametric approach of the production frontier. The mathematical program planning helps to estimate the nonparametric approach frontiers.

Measuring efficiency in Deterministic Frontier production function

$Y = b_0 + b_1X_1 + b_2X_2 + \cdots b_nX_{n+e}$

Where Y is the log of output

$X_1 \cdots ... X_n$ are the log values of inputs and e is the random error term

The equation can be rewritten as $Y_t = \hat{y_t} + e_t$

To be an efficient frontier $\sum_{i=0}^{n} b_i \; X_{it} = \hat{y_t} > y_t$

The efficient farm satisfies the conditions of e_t=0 or $\hat{y_t} = y_t$

Stochastic frontier production function

The commonly used approach in measuring the TE is the stochastic frontier approach. Initially the frontier model is estimated, usually by maximum likelihood approach and then the estimated model is used to construct measures of inefficiency or efficiency. The model was originally developed by Aigner, Lovell, and Schmidt (1977).

In the stochastic frontier production function, the error term was decomposed into two parts, the symmetric component permits random variation of the frontier across firms and captures the effect of measurement errors, other statistical noises and random shocks outside the firm. A one-sided error term captures the effects of inefficiency relative to the stochastic frontier. The technical efficiency shows the farms' ability of maximizing output with a set of given input. The range of TE is 0 to 1. TE = 1 implies that the farm is producing on its production frontier and is said to be technically efficient. Hence, (1–TE) represents the gap between actual production and optimum attainable production that can be achieved by moving the firm towards the frontier through read justing inputs (Chaves and Aliber, 1993).

Stochastic frontier models are superior to deterministic models because they include a separate symmetric component of the variation which takes care of measurement error, mis-specification of the model and exogenous shocks and one sided error term which takes care of inefficiency.

A stochastic frontier model is given as

Y=f ($X_1, X_2, X_{3\ldots\ldots}$) + (v±u)

Where v is the symmetric error component and $u_i's$ the one sided error component. The function can be estimated by maximum likelihood techniques.

With the assumptions of a half normal distribution of u_i and normal distribution of v_i the frontier model is written as Y= f ($X_1, X_2, X_{3\ldots\ldots}$)) ± (v-u)

Where u ~ N (0, σ2u) and v~ N(0,σ2v).

The parameter of gamma distribution of u, λ=σ2u/ σ2v.

The estimates of λ and σ are provided by software packages like LIMDEP/SHAZAM/SAS etc.

The technical inefficiency is given by v_i / f ($X_1, X_2, X_{3\ldots\ldots}$) where the denominator represents the estimated frontier and v_i are the upward /downward inefficiencies of individual firms

Mean technical efficiency =1- σu (2/π) 1/2

Empirical example: Technical efficiency analysis of trawlers in Tuticorin fishing harbor using stochastic frontier production function using SAS

The technical efficiency of single-day trawlers operating in Tuticorin fishing harbour was analysed using stochastic frontier production function. In the stochastic frontier production function, a stochastic component that describes random shocks affecting the production process is added. Since marine fish production is very much affected by several external factors, landings of fishing units showed variability among seasons, fishing units, fishing grounds, etc. and hence stochastic frontier models are more suitable. The data is usually collected following a multi-stage random sampling method covering all the seasons in a year to obtain the annual landings of craft. For technical efficiency analysis, multistage sampling covering the various fishing trips of the same fishing unit for at least a year including the lean and peak seasons will give better results.

SAS codes for stochastic frontier analysis

In SAS, The QLIM (qualitative and limited dependent variable model) procedure supports the stochastic frontier production function estimation. The explanatory variables (inputs) used in the model were fuel (FL), ice (IC) and labour (LB) used per fishing trip (log values) and the output was expressed as the log of fish produced per fishing trip (LQ).

The following statements create the dataset:

title1 ‘Stochastic Frontier Production Model’; data TE;

input FL IC LB LQ;

datalines;

7.0901	2.8904	3.218876	6.9565
6.9565	2.8904	3.218876	7.1053
6.9565	2.8904	3.178054	6.981
7.2793	2.8904	3.218876	7.0926
6.3969	2.8904	2.890372	6.9324

... more lines ...

```
/*-- Stochastic Frontier Production Model --*/ proc qlim data=TE; model LQ=FL LB IC; endogenous LQ ~ frontier (type=exponential production); run;
```

Results: Parameter estimates of stochastic frontier production function: mechanised trawlers in Tuticorin fishing harbour

Parameter Estimates					
Parameter	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	6.176947	0.133628	46.22	<.0001
Diesel(FL)	1	0.262065	0.047809	5.48	<.0001
Ice(IC)	1	0.037303	0.037695	0.99	0.3224
Labour(LB)	1	-0.261055	0.074543	-3.50	0.0005
_Sigma_v	1	0.358410	0.012364	28.99	<.0001
_Sigma_u	1	0.128539	.	.	.

Technical efficiency analysis of single-day trawlers in Tuticorin fishing harbor (TFH) in 2014 using stochastic frontier production function in SAS showed that diesel consumption had positive and significant influence on quantity of fish landed and labour use had negative influence on fish production. Mean Technical efficiency calculated from the estimated parameters was 71 % which indicated that 29% of boat operations were inefficient and hence there is scope to increase the technical efficiency of fishing units by efficient resource use.

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18

TRANSPORTATION MODELS: A TOOL FOR INVESTIGATING MARKET PERFORMANCE AND EFFICIENCY DECISIONS

Shyam S. Salim and Athira N. R.

An efficient marketing system is the one which is capable of moving goods from producer to consumer at the lowest cost consistent with the provision of the services that consumers demand. Fish marketing in India is characterized by uncertainties in supply, assembling fish from too many landing centres, different types/ varieties and demand patterns, numerous marketing channels, intermediaries and price fluctuations. The fishers are unaware of where to sell their fish with minimum transportation cost, what quantity to be supplied, what is the demand of a particular market, etc. Transportation models are one of the technique which analyses all these and thereby investigating the structure and performance of fish markets. Transportation models enable to understand the price variations and uncertainties in the fishery marketing systems. It helps to make aware of where to supply more fish, how much quantity to be supplied with least transportation cost and moreover it point outs the most demanding species in each markets.

Definition

Transportation models have got very wide role in all the arenas of day to day life. In fisheries, spatial market efficiency can be assessed by examining trade volumes, prices or both. Transportation theory and modeling examines the optimal transportation of commodities in markets. The transportation problem is a special type of linear programming problem where the objective is to transport various quantities of a single homogeneous commodity to different destinations in such a way that the total transportation cost is minimum. Since there is only one commodity, a destination can receive its demand from more than one source. The major objective of the model is to determine how much should be shipped from each source to each destination so as to minimize the total transportation cost. The origin of a transportation problem is the location from which shipments are dispatched and the destination of a transportation problem is the location to which shipments are transported.

Theoretical background

Transportation model has been considered as one of the important applications of Linear Programming Problem (LPP). The objective of transportation model is to determine the schedule for transportation of goods from source to destination in such a way that minimizes the shipping cost and satisfies all the demand and supply constraints. The numerous research works has been done to obtain the optimal cost of shipment in a minimum number of iterations. There are also some methods and techniques that developed in the past few years for finding the lowest cost plan in distributing goods from source to destination.

In transportation model we have to make following two assumptions.

- The requirement assumption-Each source has a fixed supply of units, where this entire supply must be distributed to the destinations. Similarly, each destination has a fixed demand for units, where this entire demand must be received from the sources.
- The cost assumptions- the cost of distributing units from any particular source to any particular destination is directly proportional to the number of units distributed. Therefore, the cost is just the unit

cost of distribution times the number of units distributed.

A general transportation model with m sources and n destinations has m+n constraint equations, one for each source and each destination. However, because the transportation model is always balanced (sum of the supply=sum of the demand), one of these equations is redundant. Thus, the model has m+n-1 independent constraint equations, which mean that the starting solution basic solution consists of m+n- 1 independent equations, which means that the starting basic solution consists of m+n-1 basic variables.

Terminology used in transportation problem :-

- Feasible solution: Non negative values of Xij where i=1,2,3……….m ; j = 1,2,3,……….n which satisfy the constraints of supply and demand
- Basic feasible solution: If the numbers of positive allocations are m+n-1
- Balanced transportation problem: A transportation problem in which the total supply from all the sources is equal to the total demand in all destinations.
- Matrix terminology: In the transportation matrix, squares are called cells and forms columns vertically and rows horizontally.

Data requirement

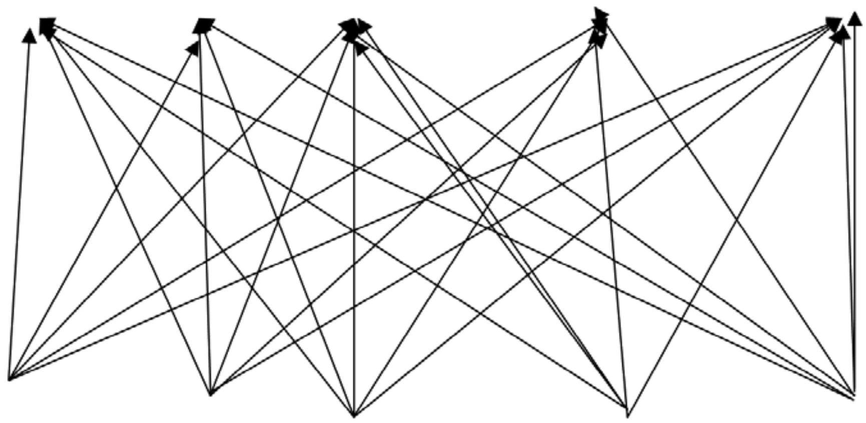
The data of the transportation model include

1. The level of supply at each source and the amount of demand at each destination.
2. The unit transportation cost of the commodity from each source to each destination.
3. Data on market prices, transportation costs and quantities transported.

Computation Techniques

The following figure represents a transportation model with m sources and n destinations. Each source or destination is represented by a node. The route between a source and destination is represented by an arc joining the two nodes. The amount of supply available at source i is ai , and the demand required at destination j is bj.

Destination (demand) b1 b2 b3 bn-1 bn



Source (supply) a1 a2 a3 am-1 am

The costs of transporting one unit between source i and destination j is cij.

Let xij denote the quantity transported from source i to destination j.

The cost associated with this movement is cost× quantity = cij xij.

The cost of transporting the commodity from source i to all destinations is given by

$$\sum_{j=i}^{n} c_{ij}\ x_{ij} = c_{i1}\ x_{i1}\ + c_{i2}\, x_{i2}\ + \ \dots\dots\dots\dots\dots\dots..\, c_{in}\, x_{in}$$

Thus, the total cost of transporting the commodity from all the sources to all the destinations is

$$\text{Total Cost} = \sum_{i=i}^{m} \sum_{j=i}^{n} c_{ij}\ x_{ij}$$

In order to minimize the transportation costs, the following problem must be solved:

$$\text{Minimize } z = \sum_{i=i}^{m} \sum_{j=i}^{n} c_{ij}\ x_{ij}$$

subject to $\sum_{j=1}^{n} x_{ij} \leq$ ai for i = 1. . . m

and $\sum_{i=1}^{m} x_{ij} \geq$ bj for j = 1. . . n where xij ≥ 0 for all i and j.

The first constraint says that the sum of all shipments from a source cannot exceed the available supply. The second constraint specifies that the sum of all shipments to a destination must be at least as large as the demand. The above implies that the total supply.

Methods to solve the transportation problems are given below;

1. North West Corner Method (NWCM)

Step 1. Start with the cell at the upper left (north-west) corner of the transportation matrix and allocate commodity equal to the minimum of rim values for the first row and first column.

Step 2. (a) If allocation made in step 1 is equal to the supply available at the first source (first row) then move vertically down to the cell (second row and first column). Apply step 1 again, for the next allocation (b) If allocation made in step 1 is equal to the demand of the first destination (first column) then move horizontally to the cell (first row and second column). Apply step 1 again for next allocation.

3. Continue the procedure step by step till an allocation is made in the south east corner cell of the transportation matrix

2. Least Cost Method (LCM)

Step 1. Select the cell with the lowest unit cost in the entire transportation table and allocate as much as possible to this cell. Then eliminate that row or column in which either the supply or demand is satisfied. If, a row and a column are both satisfied, simultaneously then crossed off either row or a column.

Step 2. After adjusting the supply and demand for all uncrossed rows and columns repeat the procedure to select a cell with the next lowest unit cost among the remaining rows and columns.

Step 3. Repeat the procedure until the available supply at various sources and demand at various destinations is satisfied.

3. Vogel Approximation Method (VAM)

Step 1. Calculate the penalties for each row (column) by taking the difference between the smallest and the next smallest unit transportation cost in the same row (Column).

Step 2. Select the row or column with the largest penalty and allocate as much as possible in the cell that has the least cost in the selected row or column and satisfies the rim conditions.

Step 3. Adjust the supply and demand and cross out the satisfied row or column.

Step 4. Repeat step 1 to 3 until the available supply at various sources and demands at various destinations is satisfied.

4. Method using Excel Solver for solving transportation problem.

Step 1. First 'Set Target Cell' for the total transportation cost which is to be minimized.

Step 2. Click on the text box 'By Changing Cells' and then select cells by clicking and dragging.

Step 3. By using the solver option, put the minimum number of iterations by hit and trial to get the optimal solution.

Step 4. To checks further for optimal solution, the result is same on increasing the number of iterations.

Worked out example

Formulating a balanced transportation problem

Suppose there are three landing centres L1,L2,L3 that supplies the needs to four fish markets M1,M2,M3,M4. Each landing centre can supply the following quantity of fish: L1, 6 tones; L2, 8 tonnes; L3, 16.The demands of the markets is as follows: M1, 4 tones; M2, 7 tones; M3, 6 tonnes; M4, 13 tones. The cost of sending 1 ton of fish from landing centre to market is as given in the table below. To minimize the cost of meeting each markets peak demand, formulate a balanced transportation problem in a transportation tableau and represent the problem as a LP model.

	M1	M2	M3	M4
L1	14	25	45	5
L2	65	25	35	55
L3	35	3	65	15

Representation of the problem as a LP model

Xij: number of (tones) fish at landing centre i and sent to market j.

Min z = 14X11 +25 X12 + 45 X13 + 5 X14 + 65 X21 + 25 X22 + 35 X23 + 55 X24 + 35 X31 + 3 X32 + 65 X33 + 15 X34

subject to :

$$\left.\begin{aligned} X11 + X12 + X13 + X14 &\le 6 \\ X21 + X22 + X23 + X24 &\le 8 \\ X31 + X32 + X33 + X34 &\le 16 \end{aligned}\right\} \text{Supply constraints}$$

$$\left.\begin{aligned} X11 + X21 + X31 &\ge 4 \\ X12 + X22 + X32 &\ge 7 \\ X13 + X23 + X33 &\ge 6 \\ X14 + X24 + X34 &\ge 13 \end{aligned}\right\} \text{Demand Constraints}$$

$$Xij \ge 0, (i= 1, 2, 3; j= 1, 2, 3, 4)$$

Solving Transportation problem using Spreadsheet Modeling and Excel Solver

A mathematical model implemented in a spreadsheet is called a spreadsheet model. Major spreadsheet packages come with a built-in optimization tool called Solver. Now we demonstrate how to use Excel spreadsheet modeling and Solver to find the optimal solution of optimization problems. If the model has two variables, the graphical method can be used to solve the model. Very few real world problems involve only two variables. For problems with more than two variables, we need to use complex techniques and tedious calculations to find the optimal solution. The spreadsheet and solver approach makes solving optimization problems a fairly simple task and it is more useful for students who do not have strong mathematics background.

Step 1 : Open the spread sheet and construct the transportation matrix with landings (L1, L2, L3, L4), markets (M1, M2, M3), supply and demand as shown below.

	M1	**M2**	**M3**	**M4**	**Supply**
L1	**14**	**25**	**45**	**5**	**6**
L2	**65**	**25**	**35**	**55**	**8**
L3	**35**	**3**	**65**	**15**	**16**
Demand	**4**	**7**	**6**	**13**	**30**

Total supply & total demand both equal 30 hence "balanced transportation problem".

Step 2: Construct a duplicate of the transportation matrix as shown.

	M1	**M2**	**M3**	**M4**	**Supply reference**	**supply**
L1					**0**	**6**
L2		Changing variables			**0**	**8**
L3					**0**	**16**
Demand reference	**0**	**0**	**0**	**0**		
demand	**4**	**7**	**6**	**13**		
Total cost						

Step 3: Click on solver: Set the objective which is here the row of total cost indicated in green colour. Click on To (min). Then Set the changing variables here it is the cells indicated in yellow colour. (i.e. insert the corresponding rows and columns)Then add the constraints in sub to constraints box .Click on add. Give the cell reference (supply reference) and the operation <=.Then give the cell constraint (supply). Repeat the same for demand constraint also. Select the linear solving method on solver. Click on solve.

The output of the problem is as shown below.

	M1	M2	M3	M4		Supply
L1	4	0	0	2	6	6
L2	0	2	6	0	8	8
L3	0	5	0	11	16	16
	4	7	6	13		
Demand	4	7	6	13		
Total cost	**506**					

The minimum cost obtained is Rs. 506

Interpretation of results

The solver results interpret that the minimum cost required to meet each markets peak demand is Rs. 506. The result also indicate that how much fish should be shipped from each landing centre to each market so as to minimize the transportation cost.

Suggested readings

- Al-Abri, Khamis. S. 2008. Efficiency of Fish Markets in Oman: Transport Modeling Analysis. Unpublished Msc thesis, Sultan Qaboos University (SQU), Sultanate of Oman.
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- Dorfman, R., P.A. Samuelson and R.M. Solow. 1958. Linear Programming and Economic Analysis, Rand Cooperation.
- Ministry of National Economy (MNE). 2006. Statistical Year Book, 2005. Ministry of National Economy, Sultanate of Oman.
- Thie, P. 1998. An Introduction to Linear Programming and Game Theory. Department of Mathematics, Boston College, USA.

Work sheet

Work sheet

Work sheet

Work sheet

Work sheet

Work sheet

Work sheet

Work sheet

The Central Marine Fisheries Research Institute (CMFRI) was establishedby Government of India on February 3RD 1947 under the Ministry of Agriculture and later it joined the ICAR family in 1967. During the course of over 69 years the Institute has emerged as a leading tropical marine fisheries research institute in the world. Since its inception, the CMFRI grew significantly in its size and stature and built up adequate research infrastructure and recruited qualified staff. During the first half of the five decades of its existence, the CMFRI devoted its research attention towards the estimation of marine fisheries landings and effort, taxonomy of marine organisms and the bio-economic characteristics of the exploited stocks of finfish and shellfish. This research effort contributed significantly to India's marine fisheries development from a predominantly artisanal, sustenance fishery till the early sixties to that of a complex, multi-gear, multispecies fisheries.

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