SUPPLY CHAIN ANALYSIS OF MARINE FISH MARKETING SYSTEM IN KERALA

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(2012 – 21 – 109)

THESIS

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DECLARATION

I hereby declare that the thesis entitled '**SUPPLY CHAIN ANALYSIS OF MARINE FISH MARKETING SYSTEM IN KERALA'** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled **''SUPPLY CHAIN ANALYSIS OF MARINE FISH MARKETING SYSTEM IN KERALA"** is a record of research work done independently by **Ms. Jeyanthi.P,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to her.

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"When you want something, the entire universe conspires in helping you to achieve it."

— Paulo Coelho, The Alchemist

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Place: Vellanikkara

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Dedicated to my dad and

my kids.......

(Aashridha and Nareshdev)

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ABBREVIATIONS

Acronyms and abbreviations

GDP	Gross Domestic Product
CMFRI	Central Marine Fisheries Research Institute
FAO	Food and Agriculture Organisation
NFDB	National Fisheries Development Board
EPC	Event Process chain
SCP	Structure- Conduct - Performance
CER	Cost Effectiveness Ratio
DEA	Data Envelopment Analysis
COLS	Corrected Ordinary Least Squares
SFA	Stochastic Frontier Analysis
DMU	Decision Making Unit
CRS	Constant Returns to Scale
VRS	Variable Returns to Scale
DRS	Decreasing Returns to Scale
IRS	Increasing Returns to Scale
CCR	Charnes, Cooper, and Rhodes
BCC	Banker, Charnes and Cooper
ECM	Efficiency Contribution Measures
PCA	Principal component Analysis
BCTE	Biased Corrected Technical Efficiency
OLS	Ordinary Least Squares
NN	Neural Network
SD	Standard Deviation
TE	Technical Efficiency
MPI	Malmquist Productivity Index
LOP	Law of One Price
IMC	Index of Market Concentration
ADF	Augumented Dickey Fuller
RBQ	Rank Based Quotient
VBI	Value Based Index
MVP	Magnitude value of the problem

E	Ernakulam
K	Kollam
I	Idukki
P	Pathanamthitta
LC	Landing centre
W	Wholesale markets
R	Retail markets
ECM	Error Correction Mechanism

Introduction

1. INTRODUCTION

Fisheries as one of the major allied sectors of agriculture contributed about 0.8 per cent to the Gross Domestic Product (GDP) and 5.15 per cent of the agricultural GDP in India (DAF&H, 2016). Fisheries sector contributes 60 per cent of animal protein to our daily diet. Fish is a highly demanded commodity and a potential export earner from among the agricultural and allied sectors. The sector provides employment and livelihood to millions of people in India (Ayyappan and Diwan, 2007). Fish provides more than one billion poor people with most of their daily animal protein. It has emerged as a major livelihood and employment generator and also makes significant contribution to foreign exchange. It is considered as one of the cheapest animal source that is within the reach of average income earner (Samson, 1997).

The availability of fish is seasonal which is reflected in the production over the years. As fish is a perishable commodity, producers are compelled to sell the catch as soon as possible without delay which may sometimes result in poor returns. Many times, they do not have another option and distress sale occurs. Fishermen usually do agreements with middlemen or auctioneer for their credit assistance during crisis and also to meet their daily fishing expenses. The holding time of fish by the producer and various marketing functionaries were also less due to lack of cold storage facilities at the landing centre and point of sales. The lack of infrastructure and price fluctuations in markets affects the market efficiency that leads to market imperfections. Fish markets differ from other agricultural and allied products markets due to its heterogeneity in terms of species, size, weight, taste, quality and price (Gopal, 2006; Kumar *et al,* 2008a).

Kerala is fourth in marine fish landings contributing 25 per cent of India's fish production. The marine fish landings in Kerala during 2016 were 5.23 lakh tonnes. Sardine, mackerel, shrimps, cuttlefish, anchovies, soles, sharks and rays are the common fish species landed. The number of fish species landed during 2015 was 466. Kerala contributed 49 per cent of fish in the south west region during 2015-16. The value of marine fish landings was Rs.48,381 and Rs. 73,289 crores respectively in landing centres and retail levels in India (CMFRI, 2015). The marine fish landings in Kerala during 2011- 16 are presented in Table 1.1.

Table 1.1 Marine fish landing in Kerala (2011 – 2016)

Year	Landings (in Lakh tons.)
2011-12	7.43
2012 -13	8.39
2013- 14	6.71
2014 - 15	5.76
2015 - 16	4.82
2016-17	5.23

Source: Various issues of Annual report, CMFRI

Marketing plays a crucial role in meeting the problems of developing countries viz., food security, poverty eradication and sustainable agriculture (Altshul, 1998; Lyster, 1990; Shamsuddoha, 2007). Marine fish marketing is characterized by uncertainties in supply, landings from various landing centres, various fish species and demand patterns, number of marketing channels, multiple intermediaries and price fluctuations (Aswathy and Samad, 2013). In India, nearly 95 per cent of fresh fish are consumed by people within 200 km from the landing centres and the rest is distributed beyond 200 km (FAO, 2008). It has been realised that there is increase in price of both fresh and value added products of fish than any other food products in India (Sathiadhas, 2006). Kerala is known for its fish consumption which is more than four times of national average (Shyam, 2012). But, the ever increasing fish demand is often met through inter-state movement of fish from other states. Moreover, there is difference between the fish consumption pattern of people in coastal and land locked regions. But, over the years the change in distributive pattern of fish has altered the fish consumption pattern of land locked regions (Ravikanth and Kumar, 2015).

Marketing of fish, as in other perishable food commodities has been influenced by the involvement of middlemen (Lawal and Idega, 2004). There is almost no or little direct contact between producers (fishermen) and consumers in fish marketing. The fish storage facility in Kerala is grossly inadequate compared to the potential for fish production and processing (Harikumar and Rajendran, 2007). The marine fish consumption is predominant in coastal districts, as marine fishes are prone to deterioration in quality during long distance transport to the land locked and hilly regions. The demand for fish in these regions was met through inland and cultured freshwater species (Salim *et al.,* 2013).

Fish wholesalers and retailers are the active market functionaries and the basis of operation and product transaction is based on mutual trust, even today (FAO, 2004). The fish market intermediaries perform an indispensable role in the marketing of fish, bridging the gap between the fishermen and the consumers. The success of various types of fishing systems depends on profitability which in turn depends on the price of different fish species. Like agricultural markets, fish markets also showed a complex structure, due to perishability and price volatility. Agricultural commodity prices are determined by demand, while fish prices are decided by supply (Sathiadas, 1997). At present, the domestic fish markets are facing multiplicity of problems including inelastic supply, high price variability, long distance between production and consumption site, unpronounced cartel operations, lack of consumer awareness and changing consumer preferences/perceptions.

Better development of fisheries sector means strengthening an efficient and integrated marketing system with less price variation. An efficient market system returns maximum share of the consumers' rupee to the producer (fisherman). The international trade is well organised but domestic fish marketing has a lot of organisational and operational lacunae (sathiadhas, 2011). Three factors such as infrastructure, information, and intelligence (3i's) are necessary for marketing.

Problem statement

It is understood that 85 per cent of fish landings is distributed through domestic fish markets (Nicholas *et al.,* 2015; Shyam *et al.,* 2015). This indicated the significance of the domestic fish marketing system. However, there are several issues plaguing domestic marketing such as lack of infrastructural facilities i.e., cold storage, poor transportation facilities, poor skills of marketing functionaries , price spread , low fish prices, high marketing costs, high temporal and spatial variation in arrivals and prices (Sathiadas and Kanagam, 2000; FAO, 2004; Rahaman *et al.,* ,2013; Jeyanthi *et al.*, 2015). Attempts are being made through policies, schemes and financial support of agencies like the National Fisheries Development Board (NFBD), Hyderabad to bring about a change in existing domestic marketing infrastructure. Standardised model markets are being constructed in different states, including Kerala.

In the domestic markets, fish is marketed through various channels involving number of market functionaries' *viz.,* wholesalers, retailers, roadside vendors, door-to-door fisherwomen vendors and motorcycle vendors. Price is often determined by the middlemen and even their cartels that lead to market imperfections. In India, domestic fish markets are failed to address the expectations of the consumers in India (Nicholas *et al.,* 2015). The awareness on nutrition, hygiene, quality and safety are increasing among consumers and this is also resulting in increasing demand for fish.

India has a strong position in International fisheries trade, but facing numerous challenges across the domestic fish supply chain. At the same time, improving the domestic fish markets with modernised infrastructure is crucial for the overall fisheries development. In this context study on fish supply chain in the domestic markets covering the major market functionaries will be useful in policy making. With this background, the present study has been framed to study the supply chain of selected fish species, market performance, market integration and price transmission of domestic fish markets in Kerala. This study was conducted to address these problems with the following objectives.

i. To identify the supply chain of selected fish species;
ii. To assess the structure and performance of domestic fish markets;
iii. To examine the market integration and price transmission among the markets
iv. To assess the consumer perception and suggest policy guidelines for improved fish marketing in Kerala.

Scope of the study

The present study would be useful in identifying the fish supply chain of the selected fish species in the domestic fish markets. The price transmission between markets will be useful to find out the degree of integration among markets. The consumer perception on fish marketing system will be useful in ensuring the supply of fish and also in identifying consumer requirements from the markets. This will ultimately help in improving the domestic fish marketing system and lead to balanced and sustainable fisheries.

Limitations of the study

The study has been conducted in a limited area and hence the results need to be carefully applied in other situations. The results of the study are based on primary data collected from respondents through pre-tested interview schedule. As the respondents were not maintaining any record books on buying price and selling price and other details, information provided is largely from memory and hence there is a possibility of recall bias. However, efforts were taken to minimise the recall bias through cross checking questions in the interview schedule.

Plan of thesis

The thesis is divided into the following five sections. The first chapter contains a brief introduction of the topic wherein the background of the research problem, objectives, scope and limitations of the study are discussed. The second chapter reviews previous studies in related areas of the study and the third chapter describes the study area, methodology and tools of analysis followed in the study. Results are discussed in the fourth chapter and a summary of the findings presented in the fifth chapter followed by references, abstract and appendices.

Review of literature

2. REVIEW OF LITERATURE

This section presents a review of the relevant work carried out in the area of supply chain of marine fish marketing system. It encompasses review of past studies relevant to the objectives and methodologies used for the envisaged objectives were also covered. This is useful to formulate concepts, methodologies and tools of analysis for similar kind of any research. The chapter has been divided into seven sections as given below.

2.1 Supply chain

2.2 Fish marketing system

2.3 Market structure

2.4 Market performance

2.5 Market integration and price transmission

2.6 Consumer preferences

2.7 Constraint analysis

2.1 Supply chain

Supply chain is defined as the sequence of processes involved in the production and distribution of a commodity. It is a network of producers, wholesalers, retailers, distributors, transporters, storage facilities and suppliers that participate in the production, delivery and sale of a product to the consumer.

Silva (2011) explained that supply chain is a system which encompasses organizations, people, activities, information and resources involved in moving a product or service from supplier to consumer. It is a complex and dynamic supply and demand network of particular commodity/ product (FAO, 2011). Supply chain is a combination of three functions i.e. procurement of raw materials, production process and distribution. It is the process of evaluating the various stages of a business till it reached the consumers. It included evaluation of every step, starting from purchase of raw material and the processes and actors in between until deliver to the hands of consumer. It comprises of refining the activities with the aim to enriching consumer satisfaction level. The basic aim is to make the system more flexible that ultimately respond to better consumer preference.

Supply chain is comprised of various mid-chain actors viz., producers, processors, wholesalers, retailers, transporters, head load labourers and consumers. Supply chain mapping is the process of representing the selected supply chain either geographical or an abstract network design. This consists of various analysis i.e., stakeholders analysis, problem analysis, objectives analysis and strategy analysis (Felix, 2012). These analyses were aimed at identifying different individuals associated with the supply chain, cause and effect and means and end and also strategies for improving the existing supply chain. Thorpe and Bennett (2004) stated that fish supply chain is the set of inter-dependent fishers, agents, processors, distributors, wholesalers and retailers including consumers in the line of transporting fish from landing centre (production point) to the consumer markets (market site). The landing centers serve as primary markets and the wholesale markets situated at a distance away from actual fish landing centers act as secondary markets. Retail markets are normally closer to the consumer. In some cases, wholesale markets have a separate retail section. New supply chain model is an advanced type of traditional supply chain which incorporated the feedback and information flow mechanism into chain. This is based on push strategy that includes consumer demand and feedback.

Supply chain is the integrated system of processes such as, acquiring raw material, transforming raw material into finished products, add value to the products, distribution and promotion of products and facilitate information exchange among functionaries. The supply chain contains two processes such as, material management (inbound logistics) and physical distribution (outbound logistics). Material management comprises of acquisition and storage of raw materials, parts and supplies. It supports material flow from raw material supply to distribution of finished products (Johnson and Malucci, 1999). Physical distribution encompasses activities related to better consumer services (Bowersox and Closs, 1996).

A supply chain comprises of multiple stakeholders (many suppliers, processors, third party distributors, retailers and consumers). They added that the success of supply chain depends heavily on availability of timely information that should be shared between members of the supply chain (Min and Zhou., 2002). The supply chain perspective involves the analysis of product and the actors (producers, wholesalers, retailers and consumers). This is faced with lot of issues and challenges i.e., trade, traceability, transparency, product quality & safety and consumer information. A supply chain has three key parts i.e., supply, manufacturing and distribution. These are explained below.

- **Supply** focuses on the raw materials supplied to manufacturing units.

- **Manufacturing** focuses on converting these raw materials into semi-finished / finished products.
- **Distribution** focuses on ensuring these products reach the consumers.

The main objective of the supply chain analysis is to produce higher quality and efficiency by co-operation rather than integration (Lazzarini *et al.,* 2001; Neves, 2003; Zylbersztain and Farina, 1999). The fish supply chain is a set of interdependent agents (fishers, processors, distributors and retailers) work together to convey the fish to the consumers. This has acquired complexity due to growth of international fish trade (Thorpe and Bennett, 2004). The peculiarity of fish supply chain is that it does not concern of supply of products only, but it is a series of interconnected flow of goods, services, incentives and information between the market functionaries in the market chain (Martinez *et al.* 2006). The co-operation and co-ordination of supply chain is essential for an effective supply chain. Now-a-days, the fisheries sector problems are becoming more complex due to multiplicity of challenges. This can be solved with the effective co-ordination of action and activities by the market functionaries. They added that both, the cooperation and coordination sides of supply chain management to be simultaneously handled (Gagalyuk *et al.,* 2009).

The three parts of supply chain are the details about supply, manufacturing and distribution. The supply includes the details about raw materials that includes how, when and from where the raw materials will be supplied. Manufacturing part includes the details about conversion of raw materials into semi-finished products. At the last, the distribution part includes the network of market function till reach the consumers (FAO, 2011). In other view, it is the quantitative analysis of inputs and outputs between firms or markets along the chain which traces the complete sequence of operations from producer to consumer (FAO, 2005).

FAO (2005) highlighted two major tasks of any supply chain analysis. These are,

i. Mapping of the chain using flow chart: It includes overview of the chain, product flows and position of actors and their interactions.
ii. Developing of economic accounts corresponding to the actors: This is activity of quantifying the activities in terms of physical and monetary terms (Fig.2.1).

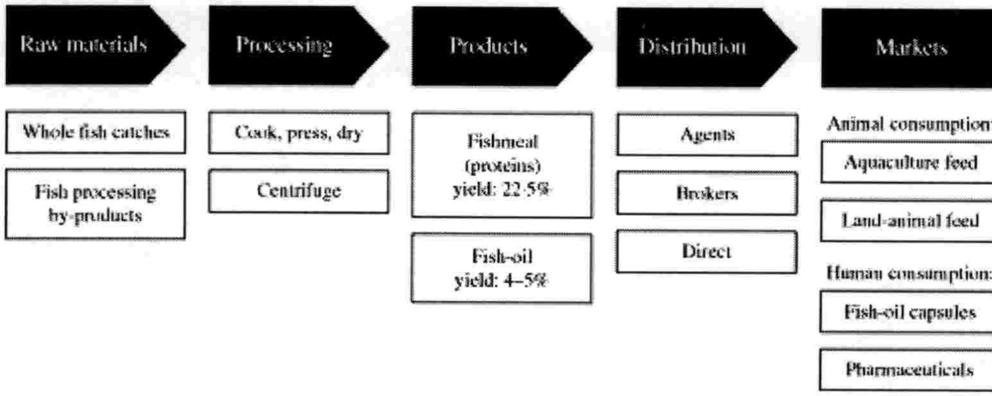

Fig.2.1 Steps in supply chain analysis

It is a key tool in improving operational efficiency. In general, the marketing channel of fish is very short due to the nature of perishability and non-availability of transparent price negotiation system.

2.2. Fish marketing system

Fish marketing is of either domestic or international which is concentrated on fresh and processed product respectively. Globally, major proportion of fish is marketed as fresh form. In India, more than 80 per cent of fish is selling as fresh, in domestic markets. The fish marketing involves producers, wholesalers, retailers, consumers and intermediaries (auctioneers). But, due to the multifunctional performances it is very difficult to document the intermediaries (Kumar *et al,* 2008).

Efficient fish marketing system is considered as indicator towards representing the growth of fish production and development of fisheries sector as a whole. Even though, inland and marine fish marketing are identical, comparatively marine fish marketing is said to be complex and complicated due to high degree of uncertainty. Due to the type of market structure, fishermen are not getting the real advantage of high price.

The characteristics of marine fish marketing are explained by Sathiadas and Kumar, (1994).

- Uncertainty in fish supply due to fish production
- High perishability nature of fish
- Fish arrivals from varied quantities at various landing centres
- Wide temporal and spatial variation in arrivals and price

- Disequilibrium between demand and supply
- Lack of proper infrastructure facilities for storage, processing, preserving and transporting
- Lack of information on production and price
- Lack of minimum hygiene and quality standards

In India, domestic fish marketing system is carried out by large number of intermediaries between producer and consumer. This is neither efficient nor modern. The market is functioning mainly by private traders with a large number of intermediaries between producer and consumer. Generally, producer (fishermen) does not sell the fish in retail markets and they do not negotiate favorable prices. Because, the product is highly perishable and not specific place in market due to strong resistance from retailers (FAO, 2001).

Domestic marketing system assumes great importance due to concentration of producers in a particular location while the consumers are spread country-wide. It was pointed out that market would be one of the crucial driving forces to sustain the fish production in future, along with technology and infrastructure (Kumar *et al.,* 2008). The growth of fish production and development of fishery sector is highly dependent on an efficient fish marketing system.

An effective marketing system should be in position to make available fish to consumers at right time and in the right place. Fish marketing is characterized by heterogeneous nature of the product regarding species, size, weight, taste, keeping quality and price. Certain other problems in fish marketing include high perishability and bulkiness of material, high cost of storage and transportation, no guarantee of quality and quantity of commodity, low demand elasticity and high price spread (Kumar, 2010; Ravindranath, 2008). Davies and Turner, (2002) explained the multi-dimensional changes in the agri-food sector over the years. They expressed certain drivers for change in these sectors.

These include production efficiency, market structures, advances in technology, competition, consumer tastes and behavior, institutional pressures and regulatory requirements, environment considerations, international and globalization issues and political influences. Unlike other agri-food sector, fish sector has an extended complication of supply variation and product perishability (Hanssen, 1996). At all the market levels, it is mostly crowded and infrastructure facilities are important for marketing fisheries products domestically and for the physical development of markets (FAO, 2001).

The export of large quantities of fish species that are considered as staple diet for the coastal community such as sardine, anchovies and ribbonfish affect the nutritional security of the sector (Gopal and Unnithan, 2006). Gopal *et al.,* 2009 mentioned about the high value and low value fish varieties while studying the finfish export competitiveness. The high value fishes viz., shrimp, seerfish and pomfret and low value fishes, sardine and mackerel showed broad spectrum of price ranges. The estimated domestic demand for fish may likely to increase with growing population as well as increasing awareness about the importance of fish in the human nutrition. Kumar *et al.,* 2010 revealed that the fish marketing can be an efficient system through access to information on prices and availability of requisite infrastructure in India.

Domestic fish marketing system in India is not so efficient, organised, regulated and far reaching modern facilities which involved large number of intermediaries between producer and consumer. Majority of fish markets are far from satisfactory in terms of physical and infrastructure facilities. (FAO, 2001). Srivastava (1985) studied the marketing of fish and fishery products in India and analyzed the inter-species and inter-state price variations. However, global consumption increases. The fish and fish products sector is facing a crisis of global dimensions: its primary resource, fish stocks, is collapsing. A number of factors related to unsustainable consumption and production patterns have led to this situation.

The market deal is finalized by the intermediary by negotiating with producer and wholesaler. For which, he receives commission from both parties which accounted about 5 per cent of the total value of fish (FAO, 2001). The intermediaries involved in any of the services such as head loading, processing,, preservation, packing, transporting and value addition at every stage of marketing (Bishnoi, 2005; Kumar, *et al.*, 2008)

Some of the problems in fish marketing include high perishability and bulkiness of material, high heterogeneity in size and weight among species, high cost of storage and transportation, no guarantee of quality and quantity of commodity, low demand elasticity and high price spread (Ravindranath, 2008; Kumar *et al.*, 2008). Fish marketing system is mainly of oligopolistic with few numbers of sellers and negligible of individual contribution. Exact information on the marketing margin of wholesalers is not available but it has been found that cost structure of wholesalers in India is profit-intensive (Gupta, 1984).

2.3 Market structure

Market structure is defined as the characteristics of the organisation of a market that establishes relationship between buyers and sellers of a homogenous product. It influences the nature of competition and pricing behaviour within the market chain. He observed that it is possible to evaluate the impact of market structure, conduct and performance by analyzing the level of the marketing margins and their cost components (Bain, 1968; Rugayah, 1993; Go *et al.*, 1999). Market structure includes number, size and market functionaries/ actors at various levels. Market conduct refers to the market co-ordination mechanisms and the pricing policies used by the actors in the supply chain. It covers the timeliness of marketing activities, of quality and regulatory mechanism related to marketing system as a whole. He used Event Process Chain (EPC) model is used in analysing the market conduct and processes in the marketing chain (William *et al.*, 2006).

Market performance is the efficiency of market, degree of integration, market price and margins, accuracy and adequacy of market information in the market. It is usually measured using marketing returns and margins. On such tool used in assessing the market structure, conduct and performance is Structure-Conduct-Performance (SCP) framework model. This indicates that market structure is influenced by conduct and these two altogether determines the market performance (Lem *et al.*, 2004). Market performance was measured using indicators such as marketing margin, cost and returns in marketing and price efficiencies. Vanessa and Jonathan (1992) used marketing margin as a method for estimating market performance. He also stated that marketing margin is the difference between producer and consumer prices of an equivalent quantity and quality of a given commodity and fluctuate depending on perish ability of products and number of functionaries in the marketing channel.

Enibe *et al.*, (2008) described the structure, conduct and performance of banana market in Anambra State of Nigeria using descriptive statistics, Gini coefficients, price spread, behaviour of middlemen, conduct of marketing functions and gross marketing margins. The Lorenz curve and the Gini co-efficient was used to assess the SCP of sweet potato marketing that showed that high inequality which indicated the oligopolistic tendencies of the sweet potato marketing (Gichangi, 2010; Odhiambo *et al.,* (2006) analysed the structure and performance of beans marketing system in Nairobi using descriptive statistics, concentration ratios and co-integration models.

Al-Abri *et al*., (2009) used transport cost-minimization linear programming models to assess the spatial market efficiency of domestic fish markets in Oman. By comparing the observed and estimated optimal prices of fish, they found that transport function of fish markets showed efficient. Giroh *et al., (*2010) also examined the structure, conduct and performance of farm gate marketing of natural rubber in Edo and Delta States of Nigeria using Gini coefficient, Budgetary technique, Market margins, Marketing Costs and Rate of Return to investment. Bright *et al*., 2015 studied the structure and performance of catfish market in Ibadan Metropolis in Nigeria. He analysed the data collected from 68 catfish sellers using gross-margin and market efficiency analysis. The market concentration was showed the non-competitive nature of structure by using the Gini-efficient. The market efficiency value calculated was 0.98 which implied no loss in the business.

Kumar *et al.,* 2008 calculated the marketing costs of fish market functionaries and found that wholesalers incurred high cost than retailers, vendors and auctioneers. The marketing cost of wholesalers was Rs. 8.89 and the retailers (Rs. 6.61), auctioneer (Rs. 0.98), and marine fishermen co-operative societies (Rs. 6). The results revealed that the infrastructure facilities available in the wholesale, retail markets were inadequate and poorly maintained and also unorganized and unregulated. In India, policy to regulate the fish marketing is not so active due to the non-mandatory nature of rules except West Bengal. In west Bengal the fish dealers' licensing order, 1975 is the only legislation available in India towards fish marketing. It contains the provisions of compulsory license and registration of market functionaries and control on inter-state supply of fish.

Usually, fishermen (producer) cannot negotiate favourable prices for their catch, due to presence of middlemen or auctioneer in the landing centres, perishable nature of produce and he doesn't have specific place to sell his fish in the market. Now- a-day, physical facilities of the fish markets are advanced through government intervention. However, washing and cleaning place, waste disposal do not have any hygienically acceptable standards. They stressed for improving sanitary and hygiene aspects in the fish markets. Otherwise, this will have adverse impact on fish marketing by lowering the fish prices and also possess health hazards (FAO, 2001). Fish marketing system is not well arranged due to high cost of storage facilities, a little attention from public agencies and mainly handled by intermediaries in marketing channels (Chourey *et al,* 2014).

The situation of the fisheries sector in Haiti is facing various problems including production, storage, processing and marketing. In many fishing communities, fishermen are facing difficulties in the preservation and sale of their catches because the local market is not structured and organized. The lack of adequate means of storage and distribution and marketing of products represents a major handicap. The lack ice accelerates the problem of preservation of seafood products on the fishing communities. This fact has serious implications on the quality of fish products available on the market, especially a perishable product like fish (Felix, 2012)

2.4 Market performance

Efficiency of organizations is assessed using techniques such as parametric (Cost Effectiveness Ratio (CER) and Data Envelopment Analysis (DEA) and non-paramatric (Corrected Ordinary Least Squares (COLS) and Stochastic Frontier Analysis (SFA)) techniques. A comparative efficiency is a method of assessing the efficiency using more than one technique and comparing the findings of the various techniques. The efficiency of health care organizations was assessed using the four techniques and compared. The results showed that the comparison between DEA and SFA showed a difference in efficiency levels of health care organizations using these two measures which is mainly attributed by the stochastic factor associated with the SFA model (Veen, 2010). The wide application of DEA is due to its strength and capability in measuring the technical efficiency of firms. Earlier, SFA was proved to be a efficiency method for assessing the technical efficiency, which showed inefficiency in case of agriculture due to stochastic noise and measurement errors (Iliyasu *et al.*, 2016). DEA performed well in the fields of banking, health, agriculture, transportation, education and manufacturing.

Data Envelopment Analysis is the mathematical tool for assessing the efficiency of particular firm. In this the data is denoted as DMUs, i.e., Decision Making Units. The term DMU was defined by Koopmans during 1950s. He defined that a DMU is said to be fully

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efficient if and only if it is not possible to improve any input or output without worsening some other input or output. As the definition is similar to Pareto efficiency, it is called as Pareto- Koopmans efficiency (Balazentis and Krisciukaitiene, 2013).

The scale efficiency impacts the overall efficiency of the DMU. The difference between Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) is that CRS focuses on productivity without considering the scale of operation. VRS explains the productivity with effect of scale of operation i.e., the DMUs under consideration are not operating at an optimum scale. Returns to scale explain the response of output with respect to change in size. The inappropriate size of DMU resulted in scale inefficiency. Generally, Scale Efficiency follows two forms viz., Decreasing Returns to Scale (DRS) and Increasing Returns to Scale (IRS). In DRS, the size is large for volume of its operation (output increases smaller portion than each input) and IRS explains the small size of volume of it's operation (output increases large proportion than each input) (Jat and Sebastian., 2013) .

Generally, two measures were used to estimate the distribution of technical efficiency of selected fishing fleets. There are single output measures (revenue) and multi-output measures (landings of various fish species). DEA is mainly used to estimate the relative performance of firms. It is considered as a powerful method for anlaysing the efficiency of production units in terms of multiple inputs and outputs. DEA as method was first proposed by Charnes, Cooper and Rhodes (CCR) during 1978, it is a non-parametric, mathematical, linear programming method. The each production units used in the method is referred as Decision Making Units (DMUs). A DMU is analyzed subject to various restrictions or limitations and it will be defined as either efficient or inefficient. The DMUs efficiency score equal to one, is said to be efficient and otherwise, it is said to be inefficient (Pascoe, S. and Mardle, S, 2003). Aisyah *et al.*, 2012 categorised the technical efficiency of fisheries in Malaysia into two regimes i.e., lower level regime and higher level regime. The TE above 80% is considered as very high efficiency and below 40% is considered as technically inefficient. He suggested that the technical efficiency can be improved by training and use of advanced technologies in the fisheries sector.

The variable selection techniques in Data Envelopment Analysis were explained by Nataraja and Johnson (2015). He stated that DEA is the widest method used to evaluate the production units' relative efficiency in both multiple input and output settings. He also

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discussed various approaches used in variable selection viz., Efficiency Contribution Measure (ECM), Principal Component Analysis (PCA), a regression based test and bootstrapping. From this, he found that PCA was performed well (even with small data sets) followed by regression, ECM and bootstrapping. Bootstrapping requires comparatively high computational hours than the other three methods. The DEA measures the efficiency with the best practicing score with in the sample and doesn't compare outside the sample. It doesn't confirm the performance of the best DMU's (Jat and Sebastian., 2013).

Iliyasu *et al.*, 2016 estimated bias- corrected Technical Efficiency (BCTE) using bootstrapping techniques in the different culture systems and species of fresh water aquaculture in Peninsular Malaysia. The two scores DEA was used to estimate technical efficiency scores against socio-economic and farm related variables. He used ordinary least squares (OLS) regression as the most appropriate as the tobit model in the second stage of DEA. Because, it gives consistent estimators and better results than the tobit regression model (Banker and Natarajan, 2008).

Mustapha *et al.*, 2013 studied the technical efficiency of aquaculture industry using DEA in Malaysia and identified regions based on technical efficiency. The least and most technically efficient farms were identified using the selected DMUs. They found that richer states preformed comparatively better than poorer states. The farms scored technical efficiency is of neutral and doesn't require any improvement in input and output allocation. It implies that they already achieved technical efficiency in resource allocation. Based on the efficient level, the DMUs were catagorised into best, average and below average performer. At the same time, it provides comparison of aquaculture performance over the years. They suggested for technical and financial assistance for the aquaculture regions to improve their efficiency levels.

DEA is a popular methodology used over the past two decades for evaluating the relative efficiencies of DMUs with in a relatively homogeneous set. It is useful in estimating the production function of organizations and organizational units and assesses their efficiency (Sun and Lu, 2005). DEA is not being used to predict the performance of other DMUs. Hence, now-a-days, to complement the DEA models, neural network models (NN) were popularly used. Mostafa (2009) used neural network models to assess the market performance of the top listed competitive companies in Egypt. He mentioned that NN models

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showed great potential for classification of companies based on relative efficiencies due to their robustness and flexibility of modeling algorithms.

Haji (2008) used DEA and Tobit regression methods to estimate the technical, allocative and economic efficiencies of vegetable-dominated mixed crop farmers and identify the factors explaining efficiency differentials among farmers in Ethiopia. The results of DEA showed that the mean technical, allocative and economic efficiency were 0.91, 0.60 and 0.56 respectively which indicates the relatively high level of technical efficiency by lower allocative and economic efficiencies. This implied that the agricultural output can be increased without using additional inputs, with the existing technology. He also added that the cost of production could be reduced by 44% with the production of same of level of output, if the farmers can able to operate at the full efficiency levels. The results of Tobit analysis showed that the farm size, income, assets, extension visits and family size were the significant factors affecting the technical efficiency of vegetable farmers.

Hailu *et al.*, (2005) measured the efficiency of fruit and vegetable marketing co-operatives in Canada and mentioned that the average efficiency was ranged between 0.615 and 0.772. The minimum and maximum efficiency of the both the co-operatives were 0.032 and 0.680 and 0.756 and 0.959 respectively. The method used for assessing the efficiency was Stochastic Frontier method. It was estimated that the mean technical efficiency was 55% and 40% during peak and non-peak season respectively. Around 37% and 62% of the fishermen had the technical efficiency level less than 40% in peak and non-peak season respectively. He also added that with appropriate training and use of advanced technologies the fishermen's level of technical efficiency can be improved (Aisyah *et al.*, 2012).

Jat and Sebastian (2013) evaluated technical efficiency of the public district hospital s in Madhya Pradesh, India using DEA. He used input oriented, VRS model to assess the performance of 40 hospitals. He found that the technical efficiency and scale efficiency score of the hospitals were 0.90 (SD = 0.14) and 0.88 (SD = 0.15) respectively. Among the DMUs, 50 per cent were technical efficient with average TE score of 0.79. This implied that the hospitals could be able to produce the same outputs by using 21 % less inputs from the current levels. And 26 per cent hospitals were scale inefficient with mean score of 0.81. He tested the robustness of the DEA results, using Jack-knifing analysis. The efficient hospitals are removed at a time and efficiency scores were recalculated. The results were then compared using Spearman's rank correlation. If the value was varied and not correlated, it implies that the outliers were influential. The value equal to zero means no correlation between rankings. The value 1 or -1 implied that the rankings are exactly same and no influence of outliers.

DEA is used as a tool for selection of portifolio in companies. The CCR method there is no possibility of increase return beyond the average return of market. But, is is possible in BCC model. He used Wilcoxon test, to study and evaluate the performance of BCC and CCR with the average return of the industries. He also tested the performance created using DEA and size effect variables for concluding the DEA and size effect variables for concluding the portifolios. He used sharpe test index criterion for testing the size effect on portifolios (Razieh and Khedri., 2013). DEA was used for performance evaluation of casino entertainment industry in Atlantic City.

They studied the managerial efficiency and found that the apparent high technical efficiency and low scale efficiency indicating the managerial efficiency. They extend the DEA based an assessment of cross-period efficiency model. The Malmquist Productivity Index (MPI) was used to determine the productivity change in a production unit. They developed a managerial decision making matrix of the performance model. Umanath and Rajasekar (2013) used input oriented DEA to estimate the technical, pure technical, scale, allocative and economic efficiency in the selected paddy farms in Madurai district, Tamil Nadu, India. The results revealed that 36 % of farms were operating at optimal scale and more than 70% were under 50% of allocative and economic efficiency levels. It was found that the farm inputs were used extensively by the sample farms.

2.5 Market integration and price transmission

Price transmission is the transfer of price from the producer to the consumer. In this process, upstream prices affect downstream prices in a marketing chain. Upstream prices are mainly the input prices or prices at the higher market levels (whole sale markets). Downstream prices are output prices or prices quoted on lower market levels (Odermero, 2013). Co-integration is a phenomenon in which two or more unit root processes (non-stationary) have linear combinations, which are stationary (Bierens, 2005). Jabri *et al.*, (2003) used Law of one price (LOP) analysis for analysis the market integration. He also stated that lack of market integration is due to the impact of current market organisation on fresh fish distribution and the prevalent pricing system which is due to the inter-regional price differences.

The fluctuation in prices of fish is very high due to uncertain, perishable nature of production, and variation in short run supply. Because the supply of fish is highly inelastic, a huge catch on any day will slash down the fish prices *vice versa (*Sathiadhas and Narayana Kumar 1994; Chourey *et al.,* 2014).

Johansen co-integration model is usually used to analyse the co-integration. It was used by Bada (2010) to study the market delineation of the fish market in Nigeria. The species-wise analysis showed that all the species are having same price on the same market and are classified as close substitutes. The market delineation method is used to determine the degree of substitution between commodities. Based on the trace and max-eigen values, it has been found that all the species are substitutes for another. The null hypothesis was rejected upto $r \leq 2$ at 1% level and upto $r \leq 3$ at 5% level.

Market integration is used to understand the interaction among prices in the spatially separated markets. It is defined as markets in which prices of the products do not behave independently (Monke and Petzel, 1984). A market is said to be integrated, if the market functionaries such as producers, wholesalers, retailers and consumers are satisfied for their produce purchased and sold.

Jabri *et al*., (2003) used Law of one price (LOP) analysis for analysis the market integration. He also stated that lack of market integration is due to the impact of current market organisation on fresh fish distribution and the prevalent pricing system which is due to the inter-regional price differences. Odermero (2013) studied the price transmission of frozen fish in Nigeria and stated that in this transmission process, upstream prices affect the downstream prices. The difference in marketing efficiency is explained by distance covered and transport cost incurred by marketers. Marketing costs and transport costs are linearly correlated.

Market integration is a precondition for an effective market reform in developing countries. Without spatial integration of markets, price signals will not be transmitted

transmitted from urban to rural areas and the producers and consumers cannot gain the true trade results. An efficient marketing system stimulates consumption as consumers are ready to buy in right form, place, time and a minimum satisfaction (Adekanye, 1988; Adenegan and Bolarinwa, 2010). He added that estimation of price transmission in the deregulated marketing system is difficult than regulated one. If different markets in the supply chain are integrated at the same or different level of supply chains, the supply chain for the product being examined can be linked.

Adenegan and Bolarinwa (2010) studied the market integration and price transmission between four categories such as local fresh, local dried, imported iced and imported dried) of fish market in urban and rural area of Oyo state, Nigeria. The prices were analysed using ADF test, granger causality and index of market concentration (IMC). They revealed that three market pair was well integrated except the rural and urban local fresh fish market.

They also found that 31 market links showed no Granger causuality, 17 market links exhibit uni-directional granger causuality and 14 exhibit bi-directional granger causuality. The urban fresh fish market occupies the leadership position in price formation and transmission. IMC indicates the low short run market integration.

2.6. Consumer preference

Conjoint analysis is a multivariate technique used specifically to understand how respondents develop preferences for products or services. He is a research tool used to analyse the consumer preference based on the value that the consumers attach to the attribute of the goods that they intend to purchase. (Siddique and Awan., 2008). It influences purchasing decisions and used a popular marketing research technique. It is used to study the trade-offs and is based on a main effects analysis-of-variance model. Scaupp and Belanger (2005) explained the six steps in the conjoint analysis study (Green and Srinivasan, 1978). The steps of conjoint analysis are presented in Table 2.1.

Conjoint analysis mainly gives information for the benefit of the manufacturers, retailers and researchers to gain better understanding of consumers' criteria when purchasing, to plan their product mixes more efficiently, to refine the marketing strategies. These are used to take decisions on market preferences, predicting market choices, developing market strategies and segmenting the market (North and de Vos, 2002).

Table .2.1 Steps used in conjoint analysis

Steps	Methods / models used	Methods/ models used in this study
Select a model of preference	Vector model (linear) Ideal point model (linear plus quadratic) Part-worth function model (piecewise linear)	Part-worth function model
Data collection method	Two factor at a time procedure Full profile approach	Full profile approach
Stimulus set construction for the full profile method	Additive compensatory model	Additive compensatory model
Stimulus presentation	Paragraph description Written instructions	Written instructions
Measurement scale for the dependent variable	Metric (ratio scale, intended scale) Non-metric (paired comparison, rank order)	Metric

Source: Green and Srinivasan, 1978

The importance of socio-demographic characteristics in studying the consumer preference was explained by Trognon *et al*., 1999. He observed that profile of the quality conscious consumers is socio-demographic, perception, knowledge and attitude factors influence the consumer behavior. The age is influential criteria for perceiving quality and differentiation. The other factors such as source of income, education, gender and location also influence the consumer behavior in greater extent.

Shine *et al.,* (1997) examined that the factors such as age, socio-economic status, marital status, number of children and household size influence the health conscious behavior. Now-a-day, consumers are nutrient and quality conscious. They are very much concerned about how, who, when and where their food is produced and also when and where they are going to purchase and consume the food or commodity/ product (Olynk, 2012). Vannoppen *et al*., (2001) developed Means-End Chain theory for mapping hierarchical value of consumers while consumer valuation of short market channels for fresh food. They used various attributes such as freshness, taste, health, pleasure and security for the consumer valuation. Geethalakshmi *et al*., (2013) studied the consumer preference and willingness-to-pay for the value added fish products in Palakkad, Kerala using conjoint analysis. The attributes such as ingredients, price, cooking method and quality at various levels. It was revealed that quality is the important attribute influencing consumer preference.

Manalo (1990) assessed the importance of apple attributes using conjoint analysis. The attributes selected for the study are size, color, price, crispiness and flavor with 2/3 levels. He revealed that size and price are significant attributes for apple purchase. Krystallis and Ness (2005) used 16 profiles with metric preference scale ('0' for non preferable, '10' for totally preferable) for assessing the consumer preferences for quality foods from a south Europe on Greek olive oil. Hailu *et al*.., (2005) measured the efficiency of fruit and vegetable marketing co-operatives in Canada and mentioned that the average efficiency was ranged between 0.615 and 0.772. The minimum and maximum efficiency of the both the co-operatives were 0.032 and 0.680 and 0.756 and 0.959 respectively. The method used for assessing the efficiency was Stochastic Frontier method.

Ariji (2010) studied the consumer reference for blue fin tuna using conjoint analysis. The attributes viz., production method, location, existence of label and price were selected for the study. He revealed that the information provided to blue fin tuna marketing has an influence on marketing. Their willingness-to-pay for full cycle farmed fish is greater compared to conventionally farmed fish. Walisinghe and Gunaratne (2012) studied the consumer preference for quality attributes of rice using conjoint analysis. From the results, he observed that the attributes such as type, color and purity were significant, but price was not significant. Purity is the e most important attribute when selecting a type of rice.

2.7 Constraints analysis

The Rank based Quotient (RBQ) is one the method used to quantify the constraints. This followed various steps such as identification of key informants, identification of respondents, quantification of data and calculation of magnitude value of constraint and final ranking. Each constraints were ranked based on the mean rank value. Higher the mean rank value of the constraints implies the low severity and vice-versa. This RBQ technique was used by Mohanty *et al.,* to analyse the constraints in agri-aquaculture in watersheds in Orissa. Krystallis and Ness (2005) used 16 profiles with metric preference scale ('0' for non preferable, '10' for totally preferable) for assessing the consumer preferences for quality foods from a south Europe on Greek olive oil. The RBQ technique was used to study the farmers' perception of critical factors for success of indigenous shrimp feed in Andhra Pradesh and Tamil Nadu. This method is used to assess the pattern of shrimp feed usage among the coastal farmers. It was revealed that competitive pricing and higher growth performance were the major key factors in the selection of shrimp feed (Ponnusamy and Swathilakshmi, 2011).

The fish marketing constraints in the Okavango delta in Botswana was studied by Mmopelwa and Ngwenya (2010). It was found out from the study that the small markets, lack of transportation facilities, high transaction costs, lack of business and management skills and lack of adequate fishing equipments were identified as major constraints. And the same was supported by previous studies that they quoted that small scale fishers in many countries are facing these majorities of constraints (Khannan *et al.*, 2003; Adeokun *et al.*, 2006). Okeoghene (2013) assessed the status of frozen fish in Nigeria and identified that poor storage/ preservation facilities, inadequate capital and marketing costs are the major constraints in marketing of frozen fish. He used Likert scale for ranking the constraints. Mukerjee (2015) used RBQ technique to rank the problems in integrated agriculture in Rampur village Patna. It was identified that crop destruction by Nilgai, inadequate availability of irrigation water and non-availability of labours at crucial time were the major problems. Ten the problems were valued using value based index (VBI) including loss percentages. Preferential ranking technique is a method used to identify the agricultural field problem faced by the Maroorpatti village, Namakkal district, Tamil Nadu. The steps used in identifying the problems by preferential ranking technique are as follows (Sabarathram, 1988).

1. Key informants identification
2. Identification of farmers
3. Quantification of data
4. Computation of rank correlation co-efficient
5. Calculate the magnitude value of the problem (MVP)

Based on the MVP, the top most problem will be identified based on the study by Venugopalan *et al.*, 1999.

Dhaka *et al.*, 2010, used the RBQ method to identify the problems faced by the maize farmers in south-eastern Rajasthan. The farmers were arranged based on the frequency distribution. The problems in poultry farming in Goa were studied by Swain *et al.*, (2009) using RBQ method. It was found that the major problem encountered by farmers in running poultry a successful enterprise was high cost of feed followed by competition with outside

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farmers and high labour cost. Rajendran *et al.*, 2010 used the RBQ analysis to identify the problems in backyard poultry farming in Thiruvannamalai district of Tamil Nadu. The problems in the backyard poultry farming were arranged in the order of seriousness on the basis of their RBQ values. Based on that, it was identified that birds falling prey to predators and damage to field crops were the serious problems. The problems of poultry farmers in India were determined using RBQ method by Mathialagan and Sabarathinam (2013). They developed a methodology for empirical research. They used the same method used by Sabarathnam and Vennila (1996) to identify the technological needs of poultry farmers.

The problems of fish markets are greater uncertainty in fish production, highly perishable nature of fish, assembling of fish from numerous landing centers, too many species and as many demand pattern violent and frequent fluctuations in prices, difficulties in adjusting supply to variations in demand and need for transportations of fish in specialized means of transport, erratic supply of electricity, inadequate cold storage facilities, stalls to display the fish and proper arrangement of sitting of marketers (Chourey *et al.,* 2014, Ayo-Olalusi *et al.*2010; Kumar *et al.,* 2008).

The most serious marketing difficulties seem to occur in the remote, land locked regions where lack of transport, ice, poor road facilities and producers are in a weaker position in relation of middlemen (Rahman, 1997). The improvement in certain aspects was highlighted by Chourey *et al.*, 2014 towards solving the problems of fish marketing. There are ensuring better marketing and distribution of fishes, improving storage system, maintain sanitation and hygienic conditions in the fish markets, introduction of modern wholesaling and retailing facilities and ensure the constant price of fish by government.

The preferences of fisheries based television programmes were ranked using RBQ technique. Based on the preferences ranked it was revealed that the aquaculture showed high rank with high preference by the viewers and fisheries schemes attracted least. They also attempted to find out the standard followed by the viewers using Kendall's Co-efficient of Concordance (W). It is found that the viewers were applying same standards in ranking the topics of preferences (Ghosh *et al.*, 2013). Dhaka and Dhaka (2016) studied the constraints faced by the farmers in agricultural production in Rajasthan. The constraints were covered under three heads viz., agro-ecological, technical and socio-economic constraints. It was indicated that dependence on monsoon, low and erratic rainfall, lack of knowledge on improved crop production practices, biotic stress, lack of suitable varieties, high cost of inputs and poor infrastructure were ranked as constraints.

Methodology

3. METHODOLOGY

This chapter deals with the research methodology used in this study. The following chapter briefly describes the area of the study, sampling design, data collection and different tools of analysis.

3.1. Area of the study

Kerala is one of the major fishing states contributing significantly to marine fish production with 5.75 lakh tonnes of annual fish production. Apart from providing livelihood support, contribution is also made in international trade. Kerala has 590 km coastline which accounts 10 per cent of India's total coastline. Marine fishery plays prominent place in the economy of Kerala (Sathiadas, 2006) and also a significant employment providing sector, varying from fishing, marketing, processing and exporting to foreign countries. The marine fisheries resources of Kerala are furnished in Table. 3.1.

Table.3.1. Marine fisheries resources of Kerala (2015-16)

Particulars	Numbers
Length of coastline (kms.)	590
Continental shelf ('000 Sq. Kms.)	40
Number of landing centres	187
Number of fishing villages	222
Number of fishermen families	118937
Number of fisher folk population	610165

Source: DAH&FS, Govt. of India, 2015

The study was confined to Kerala covering two coastal districts (Ernakulam and Kollam) and two land locked districts (Idukki and Pathanamthitta) (Fig. 3.1). Ernakulam and Kollam are the two major fishing districts which accounted 1.89 lakh tonnes of fish landings in Kerala during 2015 -16 (DoF, 2015) 2015-16.

The two major fishing harbours of Kerala viz., Munambam and Neendakara Fishing Harbour are located in Ernakulam and Kollam respectively (DoF, 2013). There exist difference in accessibility, availability, affordability and quality of fish between coastal and land locked regions.

3.2. Description of study area

Ernakulam is situated in between 9° 42' & 10°70' N latitude and 76°9' & 77°2' E longitude with an area of 3068 km^2. The district is bounded on the north by Thrissur district, on the east by Kottayam, south by Kottayam and Alleppey districts and on the west by Arabian Sea. It is also the most industrially advanced and flourishing district of Kerala compared to other districts.

Kollam is situated in between 9° 10' and 8 ° 45' N latitudes and 76° 25' and 77° 15 E longitude. It has an area of 2483 km^2 which accounted for 6.39 per cent of total area of the state (Census, 2011). The district is bounded on the north by Pathanamthitta district, on the east and south by Tirunelveli district of Tamil Nadu and Thiruvanathapuram district respectively and on the west by Arabian Sea.

Idukki is situated in between 9° 15' and 10° 21' N northern latitude and 76° 37' and 77° 25' E eastern longitudes with an area of 4358 km^2. The district is bounded on the north by Thrissur district, on the east and south by Coimbatore, Dindigul and Theni districts of Tamil Nadu and Pathanamthitta respectively and on the west by Ernakulam district. It is the only district in Kerala, only accessible by roads.

Pathanamathitta is the youngest district in the state of Kerala. It is located between 9°26' N latitude and 76°79' E longitude with an area of 2642 km^2. The districts is bounded on the north by Kottayam, on the east and south by Tamil Nadu state and Kollam district, respectively and on the west by Alappuzha district.

The criteria for selection of these study area:

1. Ernakulam and Kollam are the two major fishing districts in Kerala contributing 13 and 18 per cent to marine fish production. They have 46 km (7.80%) and 37 km (6.27%) of coastline in Ernakulam and Kollam districts respectively (DOF, Kerala). These two districts are the nodal districts of domestic fish marketing in Kerala, thus acted as a starting point for fish supply chain.

Fig. 3.1. Location of the study area

Coastal Regions

2. Idukki and Pathanamthitta are two land locked and interior districts with relatively high demand and potential areas for fish and fish products. These are fresh fish deficit regions being far away from the fish landing centres.

3.3. Sampling design

The sampling design for the study was presented in figure. 3.2. In the selected areas, a stratified sample of producers (fishermen), wholesalers, retailers and consumers were selected. In the coastal districts (Ernakulam & Kollam), producers, wholesalers, retailers and consumers were conducted. While in the land locked districts (Idukki & Pathanamthitta), wholesalers, retailers and consumers were contacted. While discussion, the name of the districts and type of markets were quoted as follows. There were Ernakulam (E), Kollam (K), Idukki (I) and Pathanamthitta (P), landing centre (LC), wholesale markets (W) and retail markets (R).

The common fish marketing channels that are associated (Panikkar *et al.* 1994; Sathiadhas and Narayana Kumar, 1994; Gopal *et al*, 2001) with marine fishes that are practiced in India are given below.

i. Channel I: Producer (Fishermen) – Wholesaler – Retailers – Vendors - consumers
ii. Channel II: Producer – Auctioneer - Wholesaler – Retailer - Consumers
iii. Channel III: Producer (Fishermen) – Wholesaler – Retailer - Consumer
iv. Channel IV: Fishermen – Auctioneer - Consumer
v. Channel V: Fishermen – Auctioneer – Commission wholesaler – Retailer – Consumers

Channel III (Producer – Wholesaler – Retailer – Consumer) has been chosen for detailed study. Even though, there were changes in the marketing channels between regions, this is considered a short, simple, easy to trace and most preferred channel next only to direct marketing.

This study was focused on the various market functionaries viz., producers, wholesalers, retailers and consumers in the fish supply chain (Fig. 3.4) and their market performance, integration among markets and consumer preference towards purchase of fish.

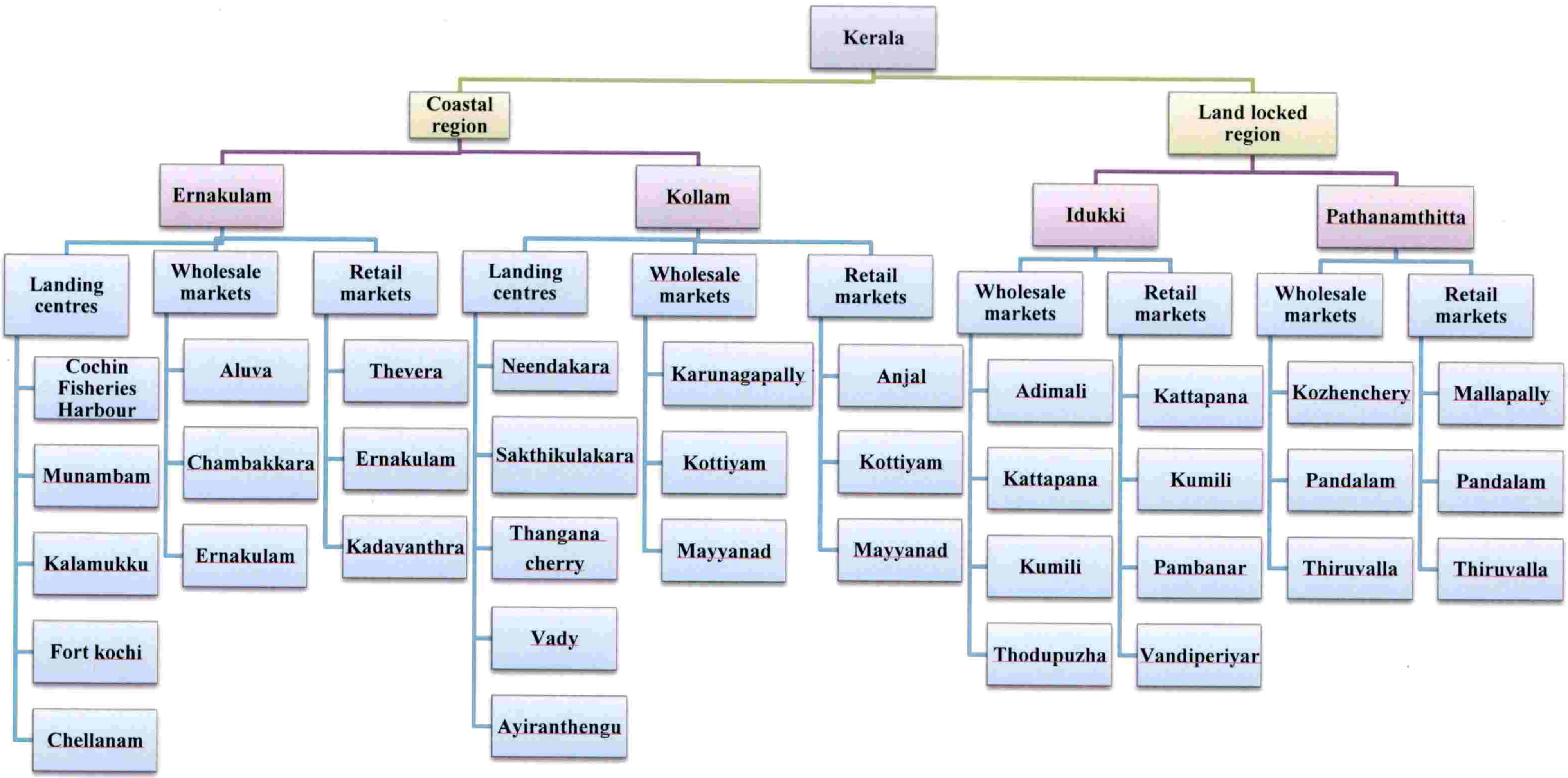


Fig. 3.2. Sampling design of the study

Fig. 3.3. Sample markets selected at Ernakulam District

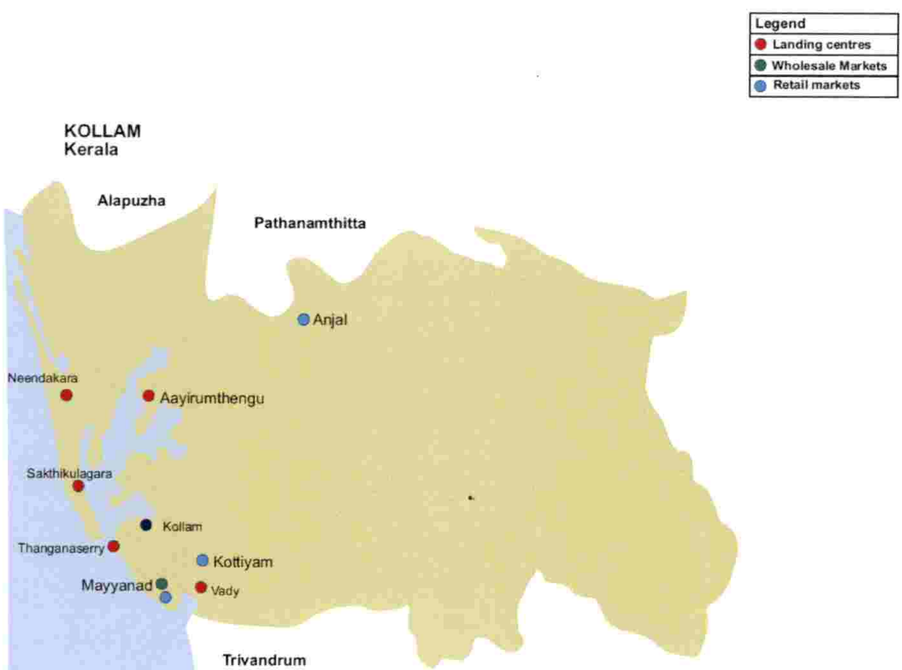


Fig. 3.4. Sample markets selected at Kollam District

Land Locked Regions

Fig. 3.5. Sample markets selected at Idukki District

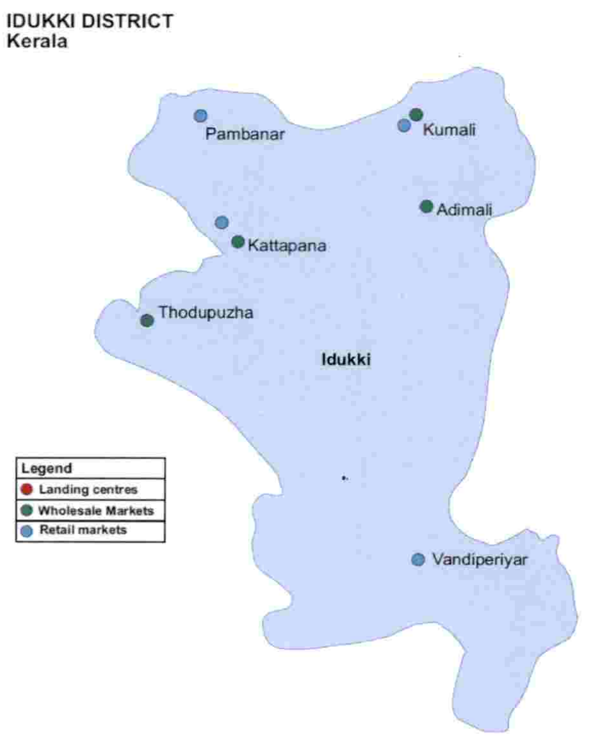


Fig. 3.6. Sample markets selected at Pathanamthitta District

SLIDES -I

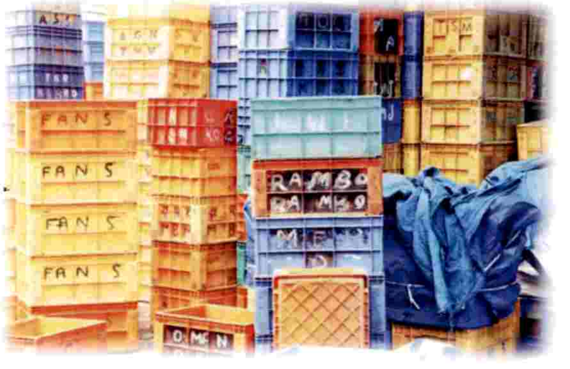
S-1. Fish display at the landing centre

S-2. Fish display at the retail market

S-3. Cleaning of fish at retail market

S-4. Selling at retail market

S-5. Retailer with tuna fish



S-6. Boxes used for transportation of fish

SLIDES II

S-7. Fishes ready for auction at retail market

S-8. Fisherwomen selling fish at retail market

S-9. Interaction with wholesalers and survey in progress

S-10 & 11. Interaction with retailers and survey in progress

S-12. Interaction with consumer at the retail market

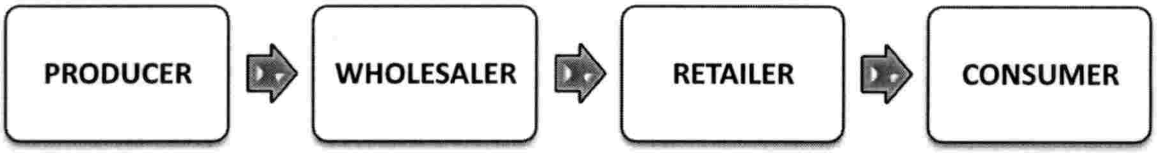


Figure 3.4. Various market functionaries in the fish supply chain

Producer

Producer is the fishermen who involving in fishing activity and landed the same in the landing centre. He usually lacks bargaining power and doesn't know the ground reality of the marketing activity. These fishermen belongs either to mechanized, motorized or motorized based on the type of craft used for fishing. The share of producer in consumer's price is very less than wholesalers and retailers.

Wholesaler

Wholesaler handles fish in bulk and transport bulk to nearby areas or to retailers and other wholesalers. They do the activities of sorting, grading, cleaning, icing and packing etc. It was found that the cost structure of wholesalers is profit intensive in India (Gupta, 1984). Icing and transportation accounted for largest share in their marketing costs.

Retailers

Retailers sell directly to the consumer or to other secondary and tertiary retailers. They do grading, cleaning, icing, packing, displaying and dressing of fish. Labour cost forms the largest share of their cost.

Consumers

Consumers are the real actors of the marketing of any product. Without consumers the marketing activity cannot be happened. The consumer purchasing power of fish is determined by income, price of the product, taste and preferences and price of other supplementary products.

The difference in performance of producers, wholesalers, retailers and consumers and fish price were assessed and compared for both coastal and land locked regions. Bishnoi, 2005 and FAO, 2011 stated that fish supply chain comprised of various intermediaries' who performed the services of loading, processing, packing, preserving and transporting in the markets.

Table 3.2 shows the number of landing centres and fish markets selected for the study. Totally, 10 landing centres were selected which consist of five landing centres at Ernakulam and Kollam respectively were selected. Among the fish markets, 12 markets in coastal and 14 markets land locked region were selected (Fig. 3.3). In total, 36 sample units consisting of 10 landing centres and 26 fish markets were selected for the study.

Table 3. 2. Number of landing centres and fish markets selected for the study

Districts	Landing centres	Fish markets	Total
I. COASTAL REGION			
(i) Ernakulam	5	6	11
(ii) Kollam	5	6	11
Total	**10**	**12**	**22**
II. LAND LOCKED REGION			
(i) Idukki	-	8	8
(ii) Pathanamthitta	-	6	6
Total	-	**14**	**14**
Grand Total	**10**	**26**	**36**

Table 3.3 shows the selection of respondents in the selected districts. Multi stage stratified random sampling method was used to select respondents at each stratum. In the coastal districts, the data were collected from 50 producers, 30 wholesalers, 30 retailers and 90 consumers each at Ernakulam and Kollam districts.

While in the land locked districts, 30 wholesalers, 30 retailers and 90 consumers were contacted each at Idukki and Pathanamthitta districts. In total, from all the four districts, 100 producers, 120 wholesalers, 120 retailers and 360 consumers were conducted. The total sample size is 700 respondents.

Tab 3.3. Selection of respondents in the selected districts

Districts	Producers	Wholesalers	Retailers	Consumers	Total
I. COASTAL					
(i) Ernakulam	50	30	30	90	**200**
(ii) Kollam	50	30	30	90	**200**
Total	**100**	**60**	**60**	**180**	**400**
II. NON-COASTAL					
(i) Idukki	-	30	30	90	**150**
(ii) Pathanamthitta	-	30	30	90	**150**
Total	**-**	**60**	**60**	**180**	**360**
Grand Total	**100**	**120**	**120**	**360**	**700**

The study was undertaken during the year 2015 – 2016. The weekly fish prices were collected during the period January to December 2016.

3.4 Collection of data

A survey was conducted with structured questionnaire towards collecting information of fish supply chain in the selected areas (Annexure II). This study involves primary data collection from various marketing functionaries (producers, wholesalers, retailers and consumers). The pre-tested interview schedule was used for the purpose. Based on this, the daily fish prices of four high value fishes (HVF) viz., seer fish, pomfret, prawns and tuna and low value fishes species viz., sardine, mackerel, anchovies and thread fin bream under were collected.

The fish species selected for the study are given in plates 1 & 2. By using the daily price data, the modal weekly prices were calculated for the price transmission of fish. This study covers the marine fishes in the domestic markets. The brief discussion of the various methodology used in assessing the various objectives such as market performance, integration of spatially separated markets, consumer preference of fish purchasing behaviour and the constraint analysis were given in the tools of analysis.

PLATE 1

High value fishes

Common name: Seerfish

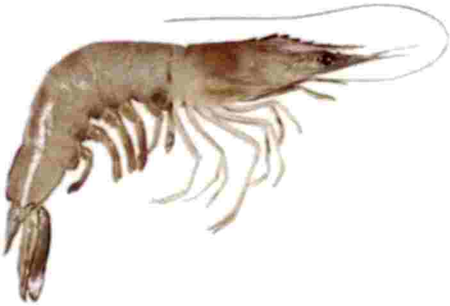
Vernacular name: Neimeen

Scientific name: *Scomberomorus commerson*

Protein: 21.34 g per 100 g of edible protein

Fat: 4.28 g per 100 g of edible protein

Rich in : Potassium (K) and Phosphorus (P)



Common name: Prawn

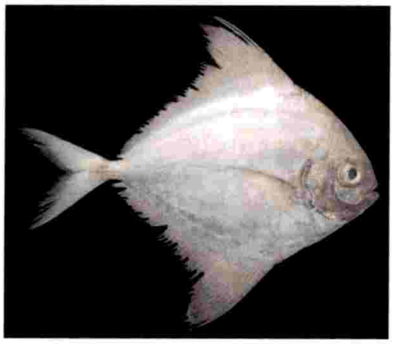
Vernacular name: Chemmen

Scientific name: *Penaeus indicus*

Protein: 20.90 g per 100 g of edible protein

Fat: 0.35 g per 100 g of edible protein

Rich in : Potassium (K) and Phosphorus (P)



Common name: Pomfret

Vernacular name: Avoli

Scientific name: *Stromateus chinensis*

Protein: 20.24g per 100 g of edible protein

Fat: 8.19 g per 100 g of edible protein

Rich in : Potassium (K) and Phosphorus (P)

Common name: Tuna

Vernacular name: Choora

Scientific name: *Euthynnus affinis*

Protein: 18.90 g per 100 g of edible protein

Fat: 4.50 g per 100 g of edible protein

Rich in : Potassium (K) and Calcium (Ca)

PLATE 2

Low value fishes

Common name: Oil sardine

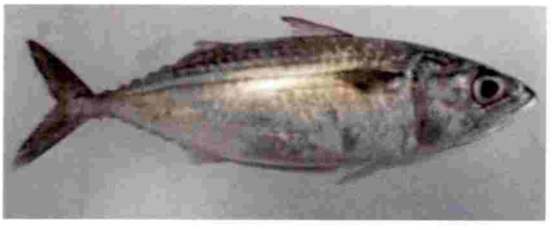
Vernacular name: Chala, Mathi

Scientific name: *Sardinella longiceps*

Protein: 19.38 g per 100 g of edible protein

Fat: 11.70 g per 100 g of edible protein

Rich in : Potassium (K) and Phosphorus (P)



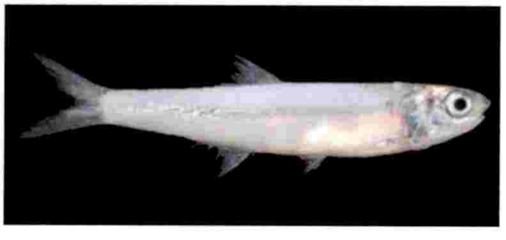
Common name: Indian mackerel

Vernacular name: Ayila

Scientific name: Rastrelliger *kanagurta*
Protein: 21.21g per 100 g of edible protein

Fat: 7.51g per 100 g of edible protein

Rich in : Potassium (K) and Phosphorus (P)



Common name: Anchovies

Vernacular name: Kozhuva,Natholi

Scientific name: *Stolephorus sp.*

Protein: 15.10g per 100 g of edible protein

Fat: 1.30 g per 100 g of edible protein

Rich in : Potassium (K) and Sodium (Na)

Common name: Thread fin bream

Vernacular name: Kilimeen

Scientific name: *Nemipterus japonicus*

Protein: 19.80 g per 100 g of edible protein

Fat: 0.44 g per 100 g of edible protein

Rich in : Phosphorus (P) and Potassium (K)

3.5. Tools of Analysis

3.5.1. Conventional Analysis

The average and percentage analysis were used to analyse the market characteristics and socio-economic status of market functionaries (producers, wholesalers, retailers and consumers).

3.5.2. Supply chain mapping

The fish supply chain in domestic marketing is unorganized with complex intra and inter-linkages between market functionaries at various stages of the supply chain (Jeyanthi *et al.,* 2015). In this study, the supply chain of fish species selected was analysed using supply chain mapping.

3.5.3. Descriptive statistics

This method of data analysis refers to the use of percentages, ratios and standard deviations in the process of comparing socio-economic details of market functionaries i.e., fishermen, wholesalers, retailers and consumers, market structure, and market prices of fish in the selected domestic fish markets.

3.5.4. Structure of domestic fish markets

The structure of landing centres and fish markets in the selected study area were described under this section. The general profile of markets in the coastal regions was collected from secondary sources such as PANFISH, Department of Fisheries for Ernakulam and Kollam districts and the same were discussed.

3.5.5. Performance of domestic fish markets

The performance of domestic fish markets was assessed using Data Envelopment Analysis (DEA) model. DEA is a non-parametric, mathematical and linear programming model generally used to assess the technical efficiency of the production units (Kongar *et al.*, 2008; Aisyah *et al.*, 2012; Umanath and Rajasekar, 2013; Bahrani and Khedri, 2013). DEA estimates a production frontier using information on inputs and outputs using frontier envelop of efficient firms. DEA used in this study is followed a two stage process. In the first stage DEA is used to estimate the level of technical efficiency of market functionaries. The second 59 stage includes regression analysis which is used to find the factors determining the efficiency levels. Two scale assumptions are generally employed: constant returns to scale (CRS), and variable returns to scale (VRS). The latter encompasses both increasing and decreasing returns to scale. CRS reflects the fact that output will change by the same proportion as inputs are changed (e.g. a doubling of all inputs will double output); VRS reflects the fact that production technology may exhibit increasing, constant and decreasing returns to scale. Input- and output-based capacity measures are only equivalent under the assumption of constant returns to scale.

Performance of domestic fish markets were assessed by estimating the technical efficiency of various market functionaries' in the markets viz., producers, wholesalers and retailers in the selected districts.

3.5.5.1 Empirical model

DEA is a multi-factor productivity analysis for estimating the relative efficiencies of a homogenous decision making units. The basic efficiency is the ratio of weighted sum of outputs to the weighted sum of inputs.

$$Efficiency = \frac{\text{Weighted sum of outputs}}{\text{Weighted sum of inputs}}$$

Assuming the number of DMUs as 'p', with 'j' inputs and 'k' outputs, the relative efficiency score is obtained by solving the relative efficiency score of DMU can be obtained by solving the following model used by Banker, Charnes and Cooper, 1984 (Ariyaratne *et al*., 2000; Kongar *et al.*, 2009).

$$Maximize \ \frac{\sum_{k=1}^{s} v_k \, y_{kp}}{\sum_{j=1}^{m} u_j \, x_{jp}}$$

$$\text{Subject to} \ \frac{\sum_{k=1}^{s} v_k \, y_{kp}}{\sum_{j=1}^{m} u_j \, x_{jp}} \leq 1 \ldots\ldots\ldots\ldots\ldots\ (1)$$

$$v_k \geq 0,$$

$$u_j \geq 0$$

Where,

K = 1 to s,

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J = 1 to m,

I = 1 to n,

y_{ki} - Amount of output '*k*' produced by DMU_i (producer, wholesaler, retailer)

x_{ji} - Amount of input '*j*' utilized by DMU_i (producer, wholesaler, retailer)

v_k - Weight assigned to output *k*,

u_j - Weight assigned to input *j*.

The above equation (1) can be converted into a linear programming model and then, the technical efficiency was estimated by solving the duality equations. Then, the scale efficiency was calculated using technical efficiency of CRS and VRS. Scale efficiency is a ratio of technical efficiency of CRS to technical efficiency of VRS. Scale efficiency is used to find the cause of inefficiency of the DMUs. If the SE = 1, the DMU is scale efficient. If SE < 1, the DMU inefficiency is mainly due to 'scale' i.e., size. If SE > 1, the inefficiency is due to 'pure' i.e., technology (Coelli, 1998). The measure of scale efficiency does not indicate whether the firm is operating in an area of increasing or decreasing returns to scale. The units were categorised based on their technical efficiency levels.

3.5.5.2 Variables used in the model

In this study, two outputs and six inputs were used to measure the technical efficiency of producers, wholesalers, retailers and consumers. The market performance is measured using outputs and inputs used by the market functionaries and the assessment was carried out through the performance of each market functionaries' viz., producers, wholesalers and retailers in the landing centres, wholesale markets and retail markets respectively. Each respondent at the producers, wholesalers and retailers are treated as a single decision making units (DMUs).

The average daily return (ADR) of each functionary was taken as outputs. The multiple inputs of producer (fishermen), wholesaler and retailers during the marketing process were considered as inputs. The inputs selected for the study are working hours/ day, working days/year, marketing cost, presence of cold storage, potable water availability and number of buyers visited per day. By using the efficient DMUs, efficient frontier was developed towards analysing the market performance of the domestic fish markets.

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3.5.5.3 Efficiency effects analysis

The second stage of analysis is on determining the factors responsible for efficiency of market functionaries. The stochastic frontier production function (SFPF) model was fitted for the variables to find out the factors determining their efficiency (Mango *et al.,* 2015). The analysis was carried out by using the technical efficiency as dependent variable and working hours per day, working days / year, marketing costs, cold storage facilities and potable water facilities, transportation and number of buyers visited of the functionaries as independent variables. The functional relationship of SFPF for the study was specified as follows.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e$$

Where,

Y – Technical efficiency scores of the respective functionaries / individual DMUs

X_1 – Working hours / day

X_2 – Working days / year

X_3 – Marketing costs

X_4 –Cold storage facility; Dummy 1, for presence of cold storage facilities

0, otherwise

X_5 – Water availability; Dummy 1, for availability of potable water

0, otherwise

X_6 – Transportation

X_7 – Number of buyers visited per day

e – Error term

a – Intercept

β_1 – Constant term

β_1------- β_7 – Co-efficient values of the parameters

The factor determining the technical efficiency was identified using the parameter co-efficient values of producers, wholesalers and retailers in the selected districts.

3.5.6 Co-integration analysis

In the present study, the daily fish prices were collected from both coastal and land locked regions for the period of one year (1^{st} January to 31^{st} December 2016). The prices were collected from selected whole sale and retail markets for the four high value and four low value fishes. Then, the daily prices were compiled and the weekly modal prices were used to find out the market integration. The weekly price series of high value fish species (Seerfish, Shrimp, Pomfret and Tuna) and low value fish species (Sardine, Mackerel, Anchovies and Thread fin bream) were analysed for assessing the market integration between domestic fish markets in Kerala. The co-integration analysis was used to assess the market integration and price transmission of fish markets in Kerala (Silva *et al.*, 2006; Adenegan and Bolarinwa, 2010). The steps involved in estimation of market integration are discussed below. In sum, four steps were distinguished: (1) Testing stationarity of the price series (2) Testing long-term price integration with co-integration analysis (3) Testing long-run integration measuring speed of adjustment and short run integration (Kombolcha *et al.*, 2007).

3.5.6.1 Step I: Test for stationarity

The first step in the co-integration analysis is stationarity test. The stationarity of the price data was tested using unit root test. The popular unit root test used for the stationarity is Augmented Dickey fuller (ADF) test. Hence, in this study, the ADF test was used to check the stationarity of price series of selected fish species. This ADF test involves the following form:

$$\Delta P_{it} = \beta_1 + \beta_{2t} + \delta P_{it-1} + \alpha_1 \sum_{t=1}^{m} \beta_1 \Delta P_{it-1} + l_{it}$$

Where,

Δ - first difference operator

ΔP_{it} – fish price series

t – time variable

β - the relationship between the price

The hypothesis is that null hypothesis (H0) $\delta = 0$ implies existence of unit root in P_{it}, i.e., the times series is non-stationary. The value of ADF statistics is compared with the critical values. If the value of the ADF statistics (t-statistics) is less than (i.e., more negative values) than critical values, it is concluded that P_{it} is stationary. When the series is found to be non- stationary, the series is first differenced to make stationary. That is,

$$\Delta P_{it} = P_{it} - P_{it-1}$$

Then, the ADF test is repeated on the first differenced series. Then, it is subjected to study the order of integration.

3.5.6.2 Step II: Application of co-integration

In this co-integration test, first the order of integration of price series was tested. If the series are integrated, then the regression is estimated. If a series, say Pt, has a stationary, invertible and stochastic after differencing d times, it is said to be integrated of order d, and denoted by Pt = I(d). The cointegration test was done for the price series that exhibited stationarity of same order. To test the market integration, the following co-integration regression was run for each pair of price series:

$$P_{it} = \beta_0 + \beta_1 P_{jt} + \varepsilon_t$$

Where,

P_{it} - price series of a fish in i^{th} market

P_{jt}– price series of fish in j^{th} market

ε_t - residual term

The test of market integration is straightforward, if P_{it} and P_{jt} are stationary variables. But if the price series proved as non-stationary, then the test of Engle-Granger test is necessary. To investigate the long-run equilibrium relationship between two time series, the co-integration model of Johnson Co-integration test was used. The maximum likelihood procedure derived by Johansen (1988), Johansen and Juselius (1990, 1992) and Juselius, 2006) was used in this study. This test derived the maximum Eigen values and trace tests between the price series to detect the number of cointegrating equations or vectors that exist between the series.

3.5.6.3 Step III: Test of causality

The third step in the co-integration analysis is the causality test. If there is existence of co-integration, the estimation of Error Correction Mechanism (ECM) will be attempted. When two series are stationary of the same order and co-integrated, the causality test is carried out. This implies the presence of long run equilibrium between variables. In this context of market integration, the speed of adjustment as one dimension of integration was analysed. This gives the long run equilibrium between the markets.The causality test using Error Correction Mechanism (ECM) is given as follows.

$$\Delta P_{it} = \beta_0 + \beta_1 P_{i(t-1)} + \beta_{2j} P_{j(t-1)} + \sum_{t=1}^{m} \delta_k \Delta P_{i(t-1)} + \sum_{t=1}^{n} \delta_k \Delta P_{j(t-1)} + l_{it}$$

Where;

Δ = first difference operator

ε t = random error term and

'm' and 'n' are the number of lags determined by Akaike Information Criterion (AIC)

3.5.6.4 Step IV: Index of Market Concentration

The index of market concentration is used to measure the price relationship between markets (Adenegan and Bolarinwa, 2010). The actual price is given as,

$$P_1 = \beta_0 + \beta_1 P_{t-1} + \beta_2 (R_t - R_{t-1}) + + \beta_3 R_{t-1} + + \varepsilon_t$$

Where,

P_{it} − Wholesale price in i[th] market

P_{jt} − Retail price in j[th] market

P_{it-1} − lagged price for P_{it}

$(P_{it} - P_{it-1})$ − difference between P_{it} and its lag

ε_t- error term

β_0 − constant term

β_1 - coefficient of ---- lagged price

β_2 - coefficient of $P_{it} - P_{it-1}$

β_3 - coefficient of urban lagged price

$$IMC = \frac{\beta_1}{\beta_3}, \text{ where } 0 \leq IMC \leq \infty$$

If,

IMC < 1 *implies* high short run market integration

IMC > 1 implies low short run market integration

IMC = ∞implies no market integration

This allows for derivation of the speed of price transmission from one location/market to another.

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3.5.7 Conjoint analysis

Conjoint analysis is used to measure, analyse and predict consumer perception of fish and identifies the additional features required for product improvement of an existing product. It is a multivariate technique mainly used to estimate how consumers develop preferences for certain products (Hair *et al.,* 1998). Consumer derives utility not from the goods themselves instead from certain attributes that the goods have possessed (Manalo, 1990).

In the study, the consumer preference of fish and fishery products was assessed using conjoint analysis. Conjoint analysis is used to determine the variety of factors/ attributes that consumers prefer while purchasing fish. The basic principle of CA is that a product is composed of attributes and each attribute may have two or three levels. Conjoint analysis was chosen because of it's simplicity. The main aim of the study is to assess how the factors and levels are perceived by the consumers. The attributes selected for CA were appearance, availability, choice, convenience, freshness, income, price, size and species.

A simpler six stage model of conjoint analysis is presented in figure.3.5. This model consists of attributes selection, determination of attributes levels, determination of attribute combinations, selection of presentation of stimuli, data collection and selection of analysis techniques.

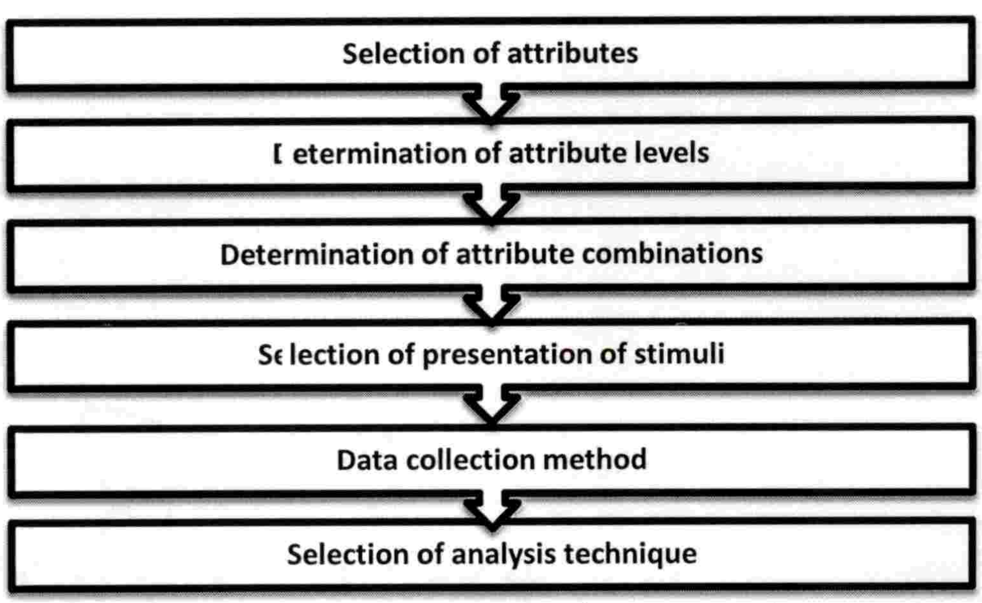

Fig 3. 5. Six stage model of conjoint analysis

(Churchill and Iacobucci, 2002)

There were five attributes selected for analysing the consumer preference of fish purchasing behaviour. The attributes and their level are shown in Table 3.4.

Tab 3.4. Attributes and their levels determining consumer preference for fish

Attributes	Description	Particulars	Levels
Availability	Distance to market	Faraway, Nearby	2
Choice	Purchase decisions	Purchasers', Family	2
Income	Consumers household income	<30000, >30000	2
Price	Value of fish	<200, 200-500, >500	3
Species	Species preference	LVF, HVF	2

The full factorial design requires large hypothetical combinations, for the given attributes and levels. To make the product profiles within the manageable level, the orthogonal design was generated with 8 cards using SPSS (version 16) software. Then, these cards were used for ranking the preferences of the respondents.

3.5.7.1 Empirical model

The range of the utility values for each attribute provides a measure of how important the factor is contributed to the overall preference. Attributes with higher utility values play a significant role. The basic model of conjoint analysis is represented as,

$$\sum_{x=1}^{n} U(x) = \sum_{i=1}^{m}\sum_{j=1}^{ki} \alpha_{ij} X_{ij}$$

Where,

U(x) = overall utility of an attribute

α_{ij} = Part – worth utility of the jth level of the ith attribute

i = 1, 2, ...,m

j = 1, 2, ...,k_i

X_{ij}= 1, if the j^{th} level of the i^{th} attribute is present

= 0, otherwise

The total utility of the consumer is found by adding all the utilities viz., availability, choice, income, price, and species and ranked by the respondents. Levels of attributes were

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The total utility of the consumer is found by adding all the utilities viz., availability, choice, income, price, and species and ranked by the respondents. Levels of attributes were re-coded using dummy variables (D1, D2….) and effect codes were used instead of typical 0,1 dummy variable coding (Adamowicz *et al.*, 1994; Harrison *et al.,* 1998; Mclennon, 2002; Lusk *et al.*, 2002), because it allows for recovery of the "left out" dummy variable while preserving the orthogonality of the design. This estimation is carried out using ordinary least square regression parametric mathematic algorithm using dummy variable regression. The relative importance (RI) of each attribute is computed from parth-worth values. It is calculated by dividing the range of its' level by the sum of the ranges across all attributes. The utility range of an attribute is the difference between the lowest part-worth utilities. The relative importance for the i^{th} attribute is calculated as,

$$RI_i = \frac{Utilityrange_i}{Sumoft \quad eutilityrangesforallattributes} \times 100$$

Where,

RI_i = Relative importance for the i^{th} attribute

Then, the conjoint analysis results should be assessed for accuracy, reliability and validity. The part-worth values are examined to determine the signs of co-efficient towards testing the model validity.

i. High adjusted R^2 value is the indicator to test the goodness of fit.
ii. Correlation (Pearson's and Kendall's tau are used to assess the reliability of the model.
iii. Value of Durbin-Watson lies between 1.25 to 2.75 indicates no auto correlation.

Generally, the first two methods will be used as a appropriate measure towards determining the validity and reliability of the model. The number of combinations was derived using the orthogonal rays to estimate the preference using utility function (Bretton-Clark, 1990).

3.5.8 Rank Based Quotient

The Rank Based Quotient (RBQ) was used to find out the constraint or problem which is getting more weightage as per the rank assigned by the respondents (Sabarathnam and Vennila, 1996; Mane *et al.,* 2007). The constraints faced by the producers, wholesalers, retailers and consumers were ranked using RBQ method.

$$\text{Rank Based Quotient (RBQ)} = \sum \frac{nFi(n+1-i)}{N \times n} \times 100 i = 1$$

Where,

Fi = Frequency of respondents for the i^{th} problem

N = Total number of respondents

n = Number of problems

The problem with highest quotient value is considered as the major constraint among others. The results obtained by analysing the collected data as per the statistical techniques discussed above are presented in the next chapter.

Results and Discussion

4. RESULTS AND DISCUSSION

The present study on 'Supply chain analysis of marine fish marketing system in Kerala' was conducted covering coastal and land locked regions of the State and the results are discussed in the following sections.

4.1 Supply chain of fish species

4.2 Structure of domestic fish markets

4.3 Socio-economic characteristics of market functionaries

4.4 Performance of domestic fish markets

4.5 Market integration and price transmission in the markets

4.6 Consumer preferences towards purchases of fish and fishery products

4.7 Constraint analysis of the market functionaries

4.8 Policy measures to improve the domestic marine fish marketing system

4.1. Supply chain of fish species

In this section, the supply chain of fish species for the selected four high value fishes-HVFs (seerfish, shrimp, pomfret and tuna) and four low value fishes-LVFs (sardine, mackerel, anchovies and threadfin bream) in Kerala were identified. The very existence of fish supply chain depends on fish landings. It is focused on integrating supplier, producer's processes, improving efficiency and reducing the waste. Unlike value chain which is on demand focus, it deals with the upstream processes and supply base (Pandey and Tiwari, 2010). First, the fish landings of the selected fish species are briefly discussed to explore the supply of the selected fish species in the domestic markets.

4.1.1 Status of fish landings of selected fish species in Kerala

The annual landings of the selected HVFs and LVFs in Kerala are presented in Table 4.1. It is observed that among the HVFs studied, the shrimp landings was high (47.56%) followed by Tuna (37.58%) and Seerfish (11.05). The least landings under HVFs was Pomfret, accounted 3.81 per cent. Mackerel and Sardine were the two high value fishes in Kerala, that contributed 29.41 and 28.41 per cent of total LVF landings. In Kerala, oil sardine was the most common fish species of Kerala and most favoured fish of the consumers in Kerala. However since 2013, it showed decreasing trend and the fish species, Indian Mackerel tops the landings in Kerala (CMFRI, 2016). The two LVFs viz., Anchovies and Thread fin breams constituted 21% each of LVF landings in Kerala. The total HVF and LVF

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landings of the selected fish species were 66216 and 161771 tonnes respectively. The total fish landings of HVF and LVFs estimated were 2.23 lakh tonnes.

Table 4.1. Annual fish landings of selected fishes in Kerala

(in tonnes)

Fish species	Fish landings
High value fishes	
Seerfish	7318 (11.05)
Shrimp	31494 (47.56)
Pomfret	2523 (3.81)
Tuna	24881 (37.58)
Total	**66216 (100.00)**
Low value fishes	
Sardine	45958 (28.41)
Indian mackerel	47253 (29.41)
Anchovies	34315 (21.21)
Thread fin breams	34245 (21.17)
Total	**161771 (100.00)**
Grand total	**227987**

Source: Unpublished data, CMFRI, 2016

Parentheses indicates the percentages of fish landings

4.1.2 Identification of supply chain of selected fish species

Even though, there is variation in composition of fish landings, the fish supply chain follows a general distribution pattern framework from producer to consumer for most of the species. The distribution pattern of supply chain varied depending on the level of integration, but the analysis usually follows a general pattern (UNEP, 2009). The generic supply chain of fish was depicted to explain the product flow through various market actors/ functionaries for the five fish species viz., seer fish, shrimp, pomfret, mackerel and anchovies. The fish species, sardine, tuna and thread fin breams needs some more additional nodes in the generic supply chain due to their importance in feed industry and country specific fish product towards meeting the demands of the seafood importing countries.

The study identified one generic supply chain and three specific supply chains for the fish species selected and the same were discussed in detail.

4.1.2.1 Generic supply chain of fish

The generic pattern of fish supply chain followed in Kerala was identified and are presented in figure 4.1. The fish is landed by fishermen in the concerned landing centre for sale. The auctioneer will intervene at this point and from this the chain has divided into two lines i.e., one is domestic market and export market chain.

In case of domestic markets, the fish supply chain follows three sub chains. In the first case, the fish is transported to the wholesale markets and from there it will be passed on to the retailers or inter-state movements of fish. From the retailers, it goes to the secondary retailers and to the consumers. The secondary retailers included retailers from outside places, door-to-door fisherwomen, motorcycle vendors and road-side vendors. In the second case, the wholesalers purchased directly from auctioneers and through retailers to consumers. While in the third case, the Wholesalers and retailers played a role in streamlining the fish to consumers. In rare cases, there may be possibility of purchasing fish directly from auctioneer.

The international trade is started with the agents who are the representatives of the seafood processing units and they purchase fish as a raw material for processing and value addition. Agents are categorized into spot or forward agents based on their nature of involvement in fish marketing. Then, the produce will be exported to the importing countries through exporters (in case of value added products) and processors (in case of processed products).

4.1.2.2 Fish supply chain of Sardine

Sardine followed the same supply chain as similar to generic fish supply chain, but comparatively different from other fishes due to addition of some additional nodes in the chain. This peculiarity of sardine supply chain is that it is a raw material for fish meal and feed industry. There were agents who collected fish from the auctioneers. Agents were the major facilitator of fish meal industry who purchases fish and to the feed industries concerned. The feed is manufactured at the industrial level and reaches the consumer through wholesalers and retailers (fig 4.2). Nearly, 25 per cent of fish landed were used for non-food products i.e., fish meal and oil.

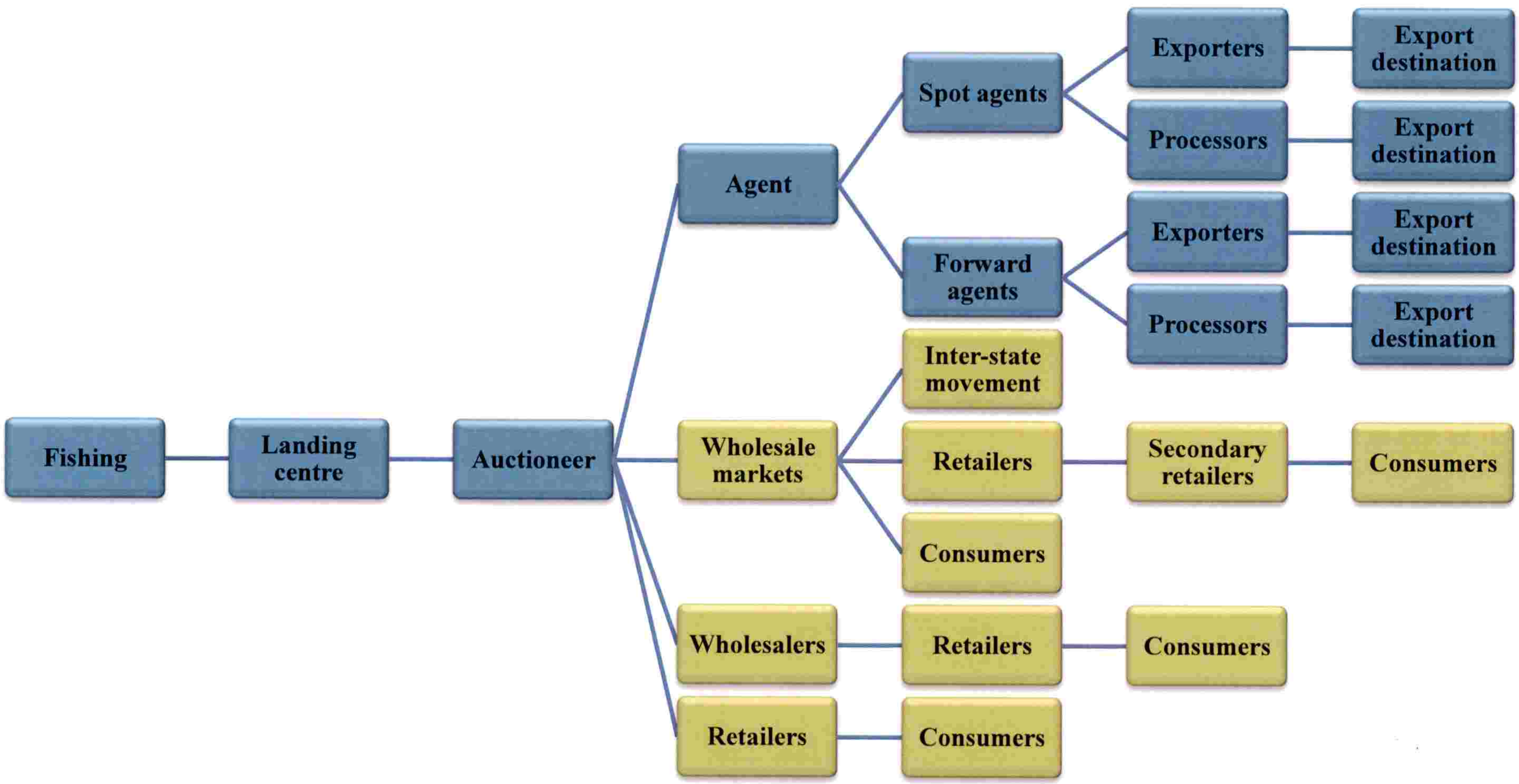

Fig. 4.1. Generic supply chain of fish in Kerala

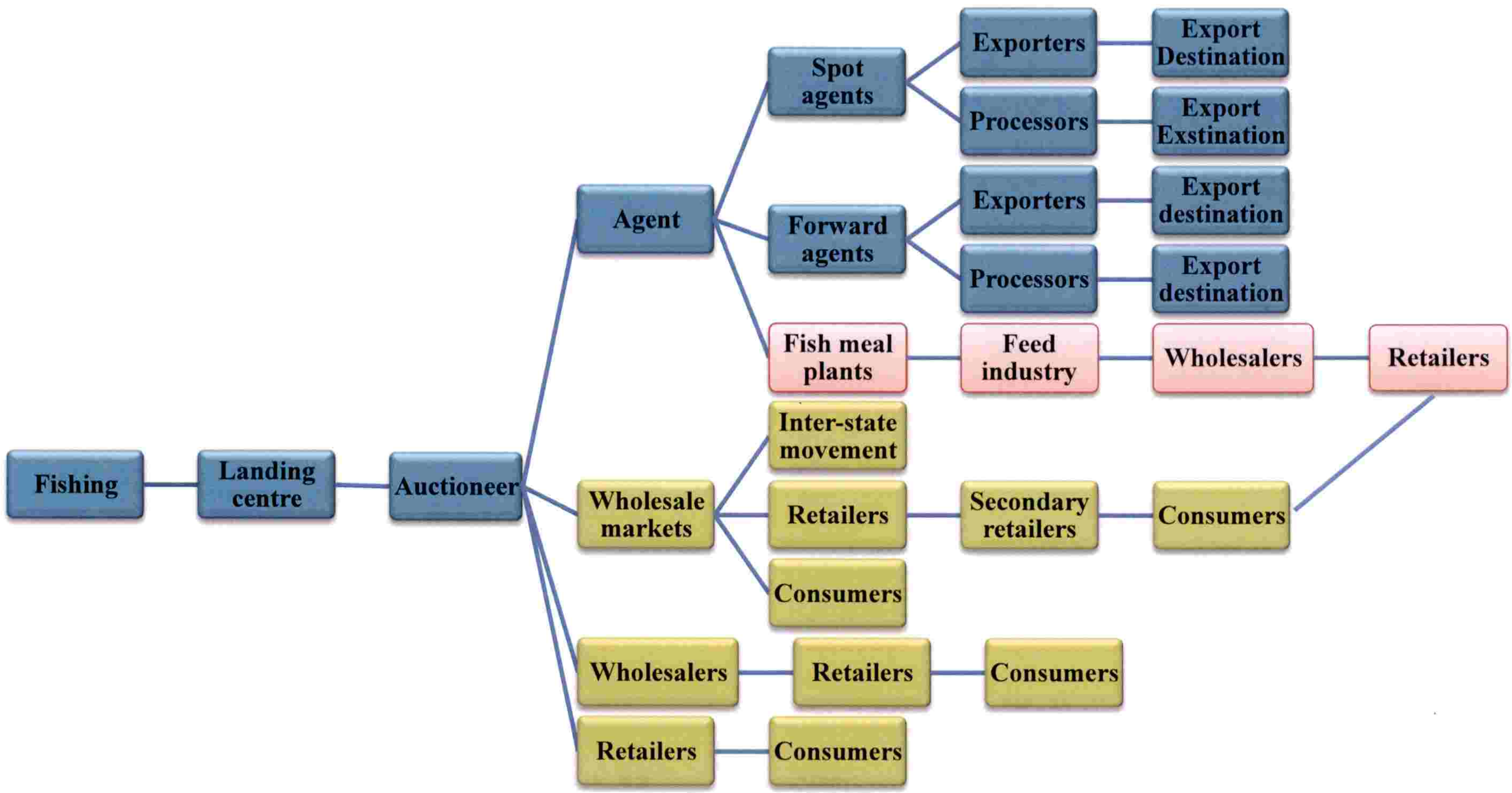

Fig. 4.2. Fish supply chain of sardine in Kerala

This had gained significance mainly to meet out the demand in the aquaculture industry (UNEP, 2009). The rest of the actors and their movement in the market followed the similar pattern. Sardine is the one such species used for fish meal. This is supported by the previous literature that some fish species are only used for fish meal alone, which affects the quantity used for human consumption. (FAO, 2002; Shyam *et al.*, 2015).

4.1.2.3 Fish supply chain of Tuna

The fish supply chain of tuna was identified and are presented in fig. 4.3. Tuna follows the distribution pattern of generic fish supply chain, the difference was in the international market with export of specialized product called Sashmi grade tuna. The other chains in the domestic markets followed the same pattern.

4.1.2.4 Fish supply chain of Threadfin bream

The fish supply chain of threadfin bream was identified and are presented in fig. 4.4. Threadfin bream follows the distribution pattern of generic fish supply chain, the difference was in the international market with export of specialized product called Surmi, exclusively to Japan. The other chains in the domestic markets followed the same pattern. From this supply chains, it was observed that there is variation in the distribution pattern of fish based on species and products. This is supported by the results of Salim *et al., (*2015) that there were widening gaps in demand – supply of fish towards meeting domestic fish demand. They expressed that there is possibility of increase in the inter-state movement of fish and imports which will alter the supply chain and intensity of market functionaries in a large way.

The ultimate motive of each market functionaries in the supply chain is for economic benefits only. This was objected by UNEP in 2009, and they had added that the issue of sustaining fish supply chains was highlighted towards improving the supply chains by incorporating social and environmental aspects. Hence, the economic motive lone will no longer exist in the long run. There are difficulty in studying the supply chain due to varied fish supply (fish landings).

The fish supply chain is peculiar to other commodities due to its highly fluctuating supply which is confirmed by Hameri and Palsson (2003). The major challenges in supply chain of fish were lack of vessel level data, inter-relatedness challenges and relationship dynamics. 76

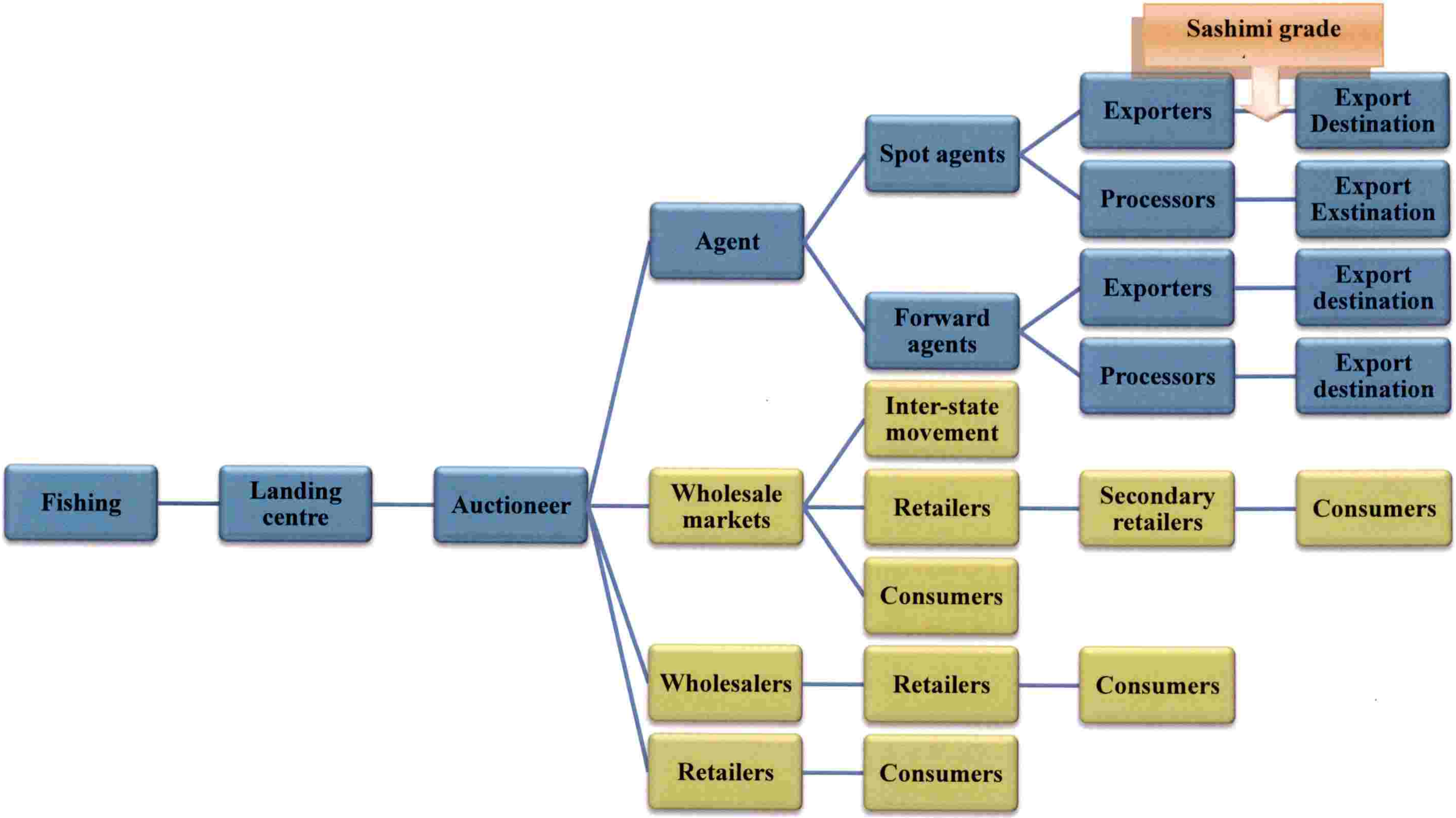

Fig.4.3 . Fish supply chain of tuna in Kerala

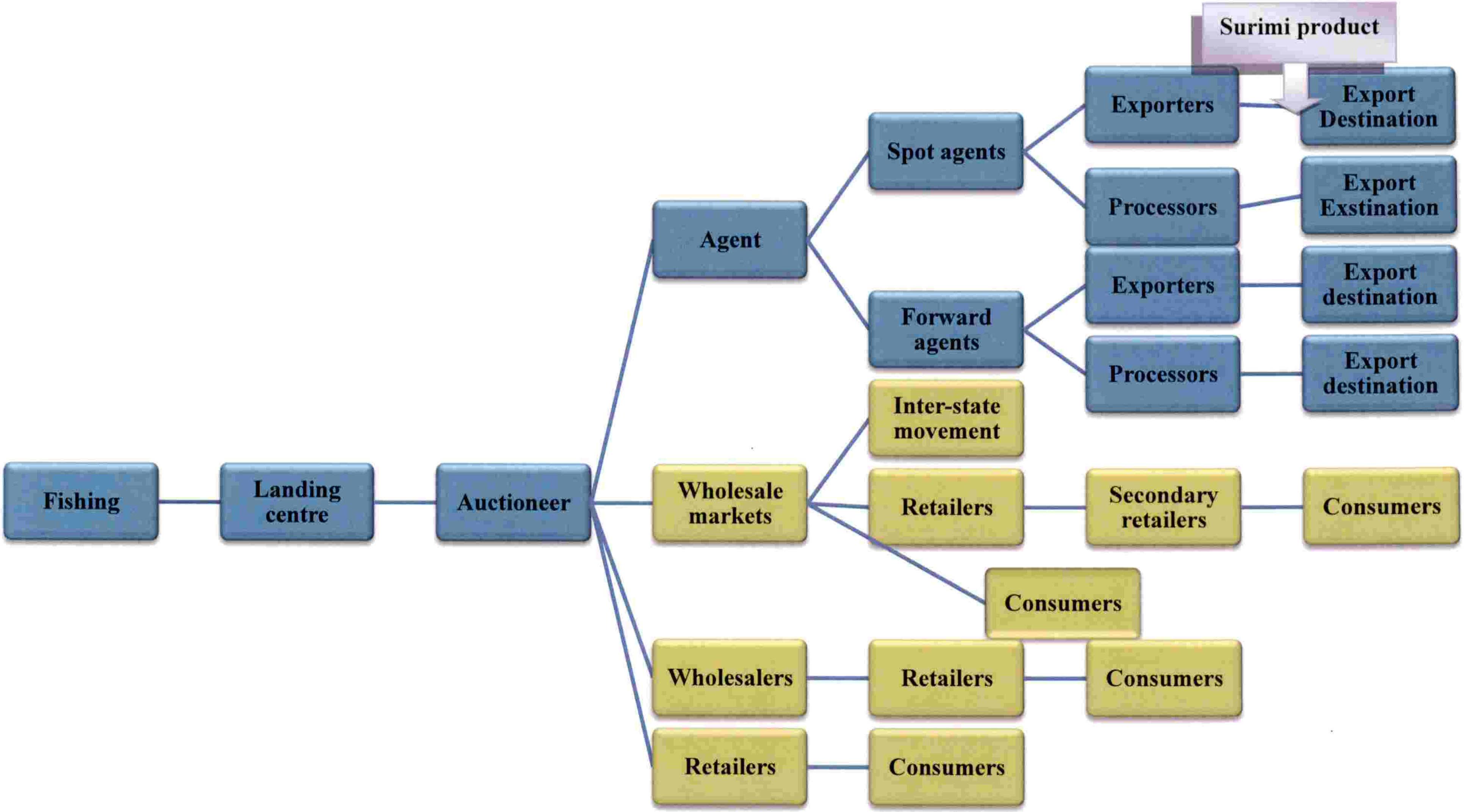

Fig. 4.4. Fish supply chain of Threadfin bream in Kerala

4.2 Structure and performance of domestic fish markets

Market is the place where the distribution pattern of supply chain starts. Marketing activity has been initiated by various market functionaries and the interaction of sellers (wholesalers and retailers) and buyers (consumers). The structure of domestic fish markets are discussed below.

4.2.1 Structure of domestic fish markets

4.2.2.1 Fish landing centres

Fish supply chain generally starts at the landing centres often called as 'starting point of supply chain' or primary markets. Among the landing centres studied, two landing centres each viz., Cochin Fisheries Harbour (CFH) and Munambam Harbour in Ernakulam district and Neendakara and Sakthikulakara landing centres in Kollam district are the major centres which accounted for largest fish landings in Kerala. The details of Cochin Fisheries Harbour (CFH), Ernakulam are given in Table. 4.2.

In all the landing centres studied, the basic infrastructures like ice plants, freezing plant and fuel outlets are inadequate and are limited in operation. There is absence of assemblage platform, cold storage facilities and price display mechanism at the landing centres which are basic for the smooth functioning of fish marketing system. The similar result was obtained by Kumar *et al,* 2008 in his study on domestic fish markets in India.

Table 4.2. Basic landing centre information of CFH, Cochin, Ernakulam

Particulars	Details
Name of the landing centre	Cochin Fisheries Harbour
Area	28 acres
Number of fishing crafts	330
Main fishing gears	Trawl net, gillnet, longlines and purse seines
Major fish species	Sardines, Mackerels, shrimps, Cuttle fish
Average quantity landed per day	330 tonnes

Source: Survey, 2016

4.2.2.2 Fish markets

The structure of fish market is studied based on the ownership pattern, market type, market timings and number of vendors visited. And, the infrastructure facilities available at the markets were also discussed. The infrastructure facilities available in the fish markets of Ernakulam district are given separately in Annexure-I.

The information on fish markets in the coastal districts of Ernakulam are presented in Table 4.3. Chambakkara is the largest market in Ernakulam and popularly called the epicentre of fish marketing from where fish is supplied to other markets both within and outside Kerala. Among the markets, Aluva, Chambakkara and Ernakulam markets have both wholesale and retail activity. Kadavanthara and Thevara are retail markets. The time of operation varies from 5am to 9pm. Based on number of vendors, Chambakkara is the biggest with about 600 vendors followed by Ernakulam (130). Thevara (40) has the least number of vendors among the markets.

Table. 4.3. General structure of fish markets in Ernakulam

Particulars	Aluva	Chambakkara	Ernakulam	Thevera	Kadavanthra
Ownership	Aluva municipality	Cochin corporation	Public	Cochin corporation	GCDA
Type of market	Wholesale & retail	Wholesale & Retail	Wholesale & Retail	Retail	Retail
Timing	6 am – 12 am	5am – 7 pm	3 pm – 9 pm	6 - 12 am	3 pm – 9 pm
Number of vendors	90	600	130	40	115

Source: PANFISH, Department of Fisheries, Kerala (2011)

The information on fish markets in the coastal districts of Ernakulam are presented in Table 4.4. Karunagapally is owned by the local Municipality, Kottiyam by Public and Panchayat owned by the Mayyanad and Anchal markets. Two markets have retailing activity only (Kottiyam and Anchal) and the others have both wholesale and retail markets.

Table 4.4. General structure of fish markets in Kollam

Particulars	Karunagapally	Kottiyam	Mayyanad	Anchal
Ownership	Municipality	Public	Panchayat	Panchayat
Type of market	Wholesale & Retail	Retail	Wholesale & Retail	Retail
Timing	6 am – 12 am	6.30 am–1 pm	3 pm – 9 pm	7 am – 12 am
Number of vendors	60	50	130	100

Source: PANFISH, Department of Fisheries, Kerala (2011)

It was found that the structure of markets has showed differences in terms of ownership pattern, market type, timing and number of vendors between the markets. Also, it is said that infrastructure development in the markets are the indicators for judging the quality of fish. It was revealed from the study, that marketing infrastructure is essential for the fullest development of fish marketing system. This includes cold storage, supply of ice, insulated transport facilities, landing centres and wholesale markets is normally inadequate, unhygienic and not up to satisfactory. There is no difference in infrastructure facilities in terms of scale of operation. Almost, all fish markets do not have cold storage facilities, no mechanism for price display, drainage facilities and potable water supply. From the basic infrastructure facilities of the selected fish markets, it is clear that the existing facilities were not supportive in supplying good quality fish to consumers. The same results were found by NATP report, (2005) and Hasan *et al.,* (2014).

4.3 Socio-economic profile of market functionaries

Socio-economic characteristics are an indicator for assessing the standard of living and livelihood status of particular community. The socio-economic details of the producers, wholesalers and retailers such as age, education, family size, experience and household income are below.

4.3.1 Age of market functionaries

The age of market functionaries in coastal and land locked regions are presented in Table. 4.5. The age of various market functionaries in the supply chain i.e., producers, wholesalers, retailers and consumers are presented in Table 4.5. It showed that the average age of producers were 47 and 48 years in Ernakulam and Kollam respectively. They were in the age of less than 50 years in the wholesalers, retailers and consumer category, both in

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coastal and land locked regions. In total, majority were in the age group of 36 – 55 years i.e., 53, 57, 54 and 58 per cent respectively in producers, wholesalers, retailers and consumers belongs to the Ernakulam, Kollam, Idukki and Pathanamthitta districts of Kerala.

Table 4.5. Age of market functionaries of coastal and land locked regions

Market functionaries	Coastal region			Land locked region		
	Ernakulam	Kollam	Total	Idukki	Patanamthitta	Total
Producers	47	48	47	-	-	-
Wholesalers	48	48	48	47	46	46
Retailers	47	47	47	49	48	48
Consumers	48	48	48	50	47	49

They were in the age group of young, active and working group, as marketing needs skill and strength for various activities. In Kerala, 61.39 per cent of marketing and processing respondents belonged to the age group of 36 – 55 years (Nikita *et al.*, 2014 & 2015).

4.3.2 Educational status of market functionaries

Education plays a major role in achieving livelihood of fishing community (Maddox, 2007). Hence, the education level of market functionaries (producers, wholesalers and the retailers) were studied. The level of education is expressed as primary, secondary and collegiate. Majority of producers were completed their secondary level of education with 48 and 42 per cent in Ernakulam and Kollam district respectively (fig.4.5). The primary and collegiate estimated were 28 and 24 per cent in Ernakulam and the same in Kollam was 32 and 26 per cent.

It was highlighted that the literacy level of fishermen in Kerala were more (77.01) than the general literacy rate (73.52) in India, though less than the literacy levels in Kerala state. And the fishers with secondary level of education (56.69%) were more in India (Sathiadhas *et al.,* 2014). The same results obtained for the producers at Ernakulam and Kollam.

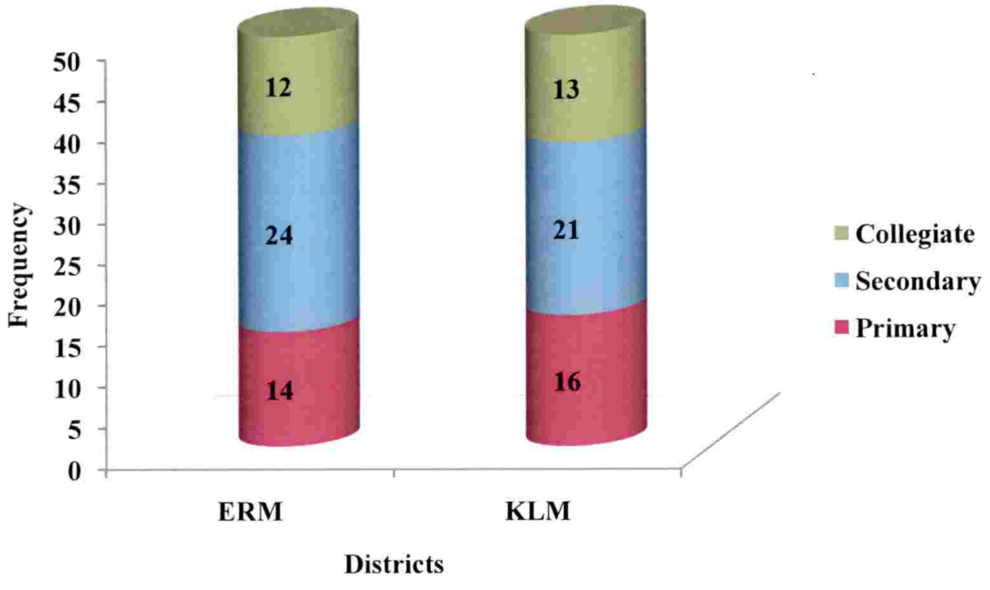

Fig.4.5 Educational status of producers in Kerala

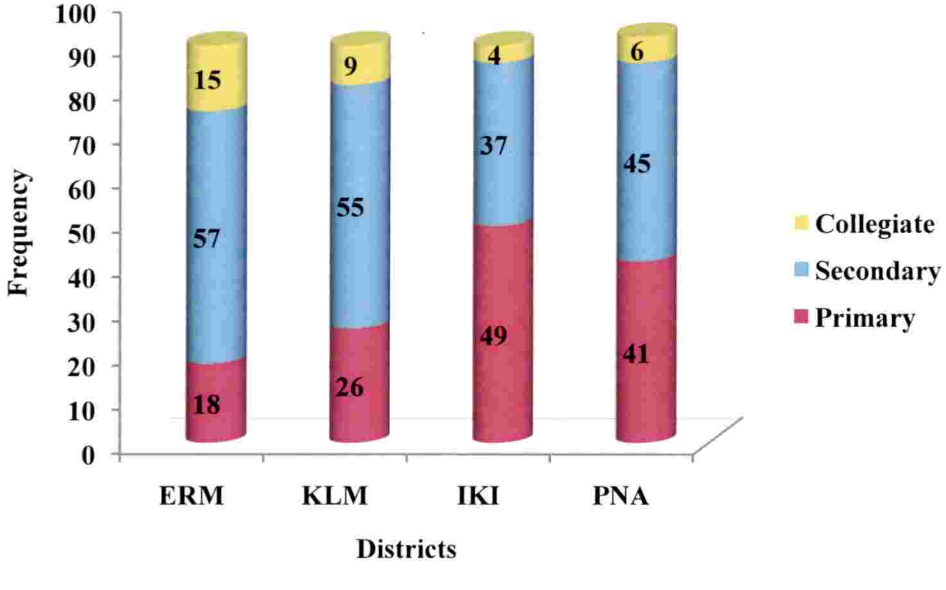

Fig.4.6 Educational status of wholesalers in Kerala

** ERM – Ernakulam; KLM – Kollam; IKI – Idukki; PNA – Pathanamthitta*

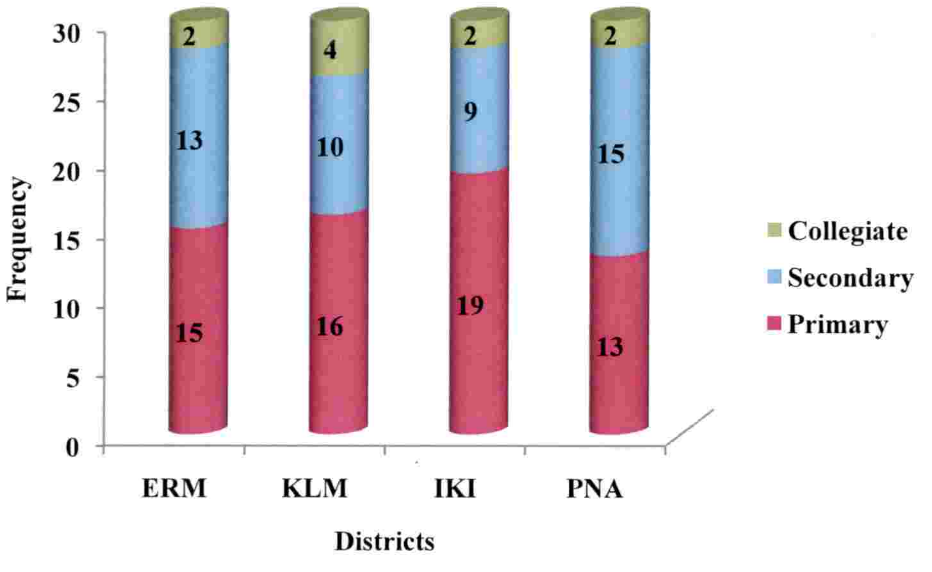

Fig.4.7 Educational status of retailers in Kerala

** ERM – Ernakulam; KLM – Kollam; IKI – Idukki; PNA - Pathanamthitta*

It was confirmed by the previous studies that fishermen were obtained secondary educational level which is not having any influence on their bargaining power towards increasing their revenue levels due to absence of price mechanism and marketing information (Ahmed, 2007).

Majority of wholesalers completed their secondary level of education in all the selected districts except Idukki. In Kollam, 63.33 per cent of respondents completed secondary level followed by Ernakulam (56.67%) and Pathanamthitta (53.33%). In Idukki, it was 40 per cent. In Idukki, majority were in the primary level of education (53.33%), only 6.67 per cent comprised of collegiate. Unlike the coastal regions, in the land locked regions, the composition of respondents under primary is more.

There are less respondents under collegiate that accounted 6.67 and 13.33 per cent in Idukki and Pathanamthitta respectively (Fig.4.6). In brief, the literacy rate of fishers in the post-harvest fisheries sector was highest in Kerala. This was supported by Nikita *et al.,(* 2014). The education level of retailers is depicted in Fig.4.7. From this, it was found that more than 85 per cent of respondents completed primary and secondary level of education in Ernakulam and Kollam, while around 80 percent of retailers were under primary and secondary level of education. But, the percentage of retailers under primary level was more in the land locked regions than coastal regions.

It was observed from the fig. . that consumers had completed their secondary level of education in Ernakulam (63.33%), Kollam (61.11%), Pathanamthitta (50.00%) and Idukki (41.11). In Idukki, the consumers in the primary level were more (54.44%). The consumers holding collegiate were more in Ernakulam (16.67%) followed by Kollam.

4.3.3 Experience of market functionaries

The average experience of producers was 15 and 17 years in Ernakulam and Kollam respectively. The overall experience of producers in the coastal region was 16 years. The experience of wholesalers in Ernakulam and Kollam was 17 and 16 with overall average of 17 years. The same in Idukki and Pathanamthitta was 9 and 13 years. In the coastal region, retailers were having more than 15 years of experience unlike land locked region (Table 4.6).

Table 4.6. Experience of market functionaries of coastal and land locked regions

Market functionaries	Coastal region			Land locked region		
	Ernakulam	Kollam	Total	Idukki	Patanamthitta	Total
Producers	15	17.	16	-	-	-
Wholesalers	17	17	17	9	13	11
Retailers	15	15	16	7	15	11

The maximum experience was gained by the wholesalers (Ernakulam) and producers (Kollam) in the coastal region. It was by retailers (Pathanamthitta) and wholesalers (Idukki) in the land locked region. The inter-regional comparison showed that the respondents in the coastal region had more experience in marketing than land locked regions.

4.3.4 Family size of market functionaries

It was observed that the average family size was 4.35, 4.15, 4.15 and 4.70 under the producers, wholesalers, retailers and consumer category respectively in the coastal region. While in the land locked region, it was 4.4, 4.7 and 4.5 under wholesalers, retailers and consumers respectively. Around 60 per cent of respondents were in the size group of 2-4 in a household (Table 4.7).

Table 4.7. Family size of market functionaries

Market functionaries	Coastal region			Land locked region		
	Ernakulam	Kollam	Total	Idukki	Patanamthitta	Total
Producers	4.4	4.3	**4.35**	-	-	-
Wholesalers	4.1	4.2	**4.15**	4.6	4.2	**4.4**
Retailers	4.3	4.0	**4.15**	4.9	4.5	**4.7**
Consumers	4.8	4.6	**4.70**	4.2	4.7	**4.5**
Total	**4.4**	**4.28**	**4.34**	**4.57**	**4.47**	**4.43**

This result revealed that the nuclear family is the predominant family type among the market functionaries. The same results were obtained by Narayanakumar and Krishnan, (2013) and Jeyanthi *et al.,* (2016). According to Bappa *et al*., (2015) mentioned that the reason behind small family norm is due to improvement in education level, diverse employment opportunities and the resultant increase in standard of living.

4.4 Performance of domestic fish markets

Market performance is the product of two concepts viz., market structure and conduct and was assessed by estimating the marketing efficiency. Performance of domestic fish markets was assessed by studying the efficiency of producers (fishermen), wholesalers and retailers using Data Envelopment Analysis (DEA). The respondents in the each category viz., producers, wholesalers and retailers in the domestic fish markets are treated as single decision making units (DMUs). The technical efficiency was assessed using DEA and the results are discussed among and between DMUs in the category, districts and regions and presented in this section.

4.4.1 Performance of producers in the fish marketing system

Producers are the fishermen who usually land fish at the landing centres i.e., primary markets, located in the coastal regions. The producer's performance was evaluated using one output and six inputs. The variables used in the DEA model are presented in Table 4.8. The average daily revenue (ADR) of producers' at the selected landing centres in Ernakulam ranged between Rs. 0.12 to Rs.0.28 lakhs. The overall average ADR was Rs. 0.23 lakhs. The overall average working hours per day and working days per year was 4.52 and 328 respectively. Marketing costs ranged between Rs.937.50 to Rs.1712.90. The average number of buyers per day was 51.

Table 4.8. .Input – output variables - Producers of Ernakulam district

Variables	LC_1	LC2	LC3	LC4	LC5	Overall
Outputs						
ADR (Rs. lakh.)	0.23	0.28	0.22	0.21	0.12	0.23
Inputs						
Working hours /day	5.4	5.3	4.2	4.3	3.5	4.52
Working days /year	327	330	324.8	321	334.5	328.2
Marketing cost (Rs.)	1359	1712.90	1238.50	1140.50	937.50	1303.28
Cold storage (dummy)	1.1	1.3	1.3	1.1	1	1.2
Water availability (dummy)	1.2	1.4	1.3	1.0	1	1.2
No. of buyers	54	65	55	50	27	51.18

(LC- Landing centre)

** LC1–Cochin fisheries Harbour, LC2-Munambam, LC3-Fort Kochi, LC4-Vypeen and LC5- Chellanam*

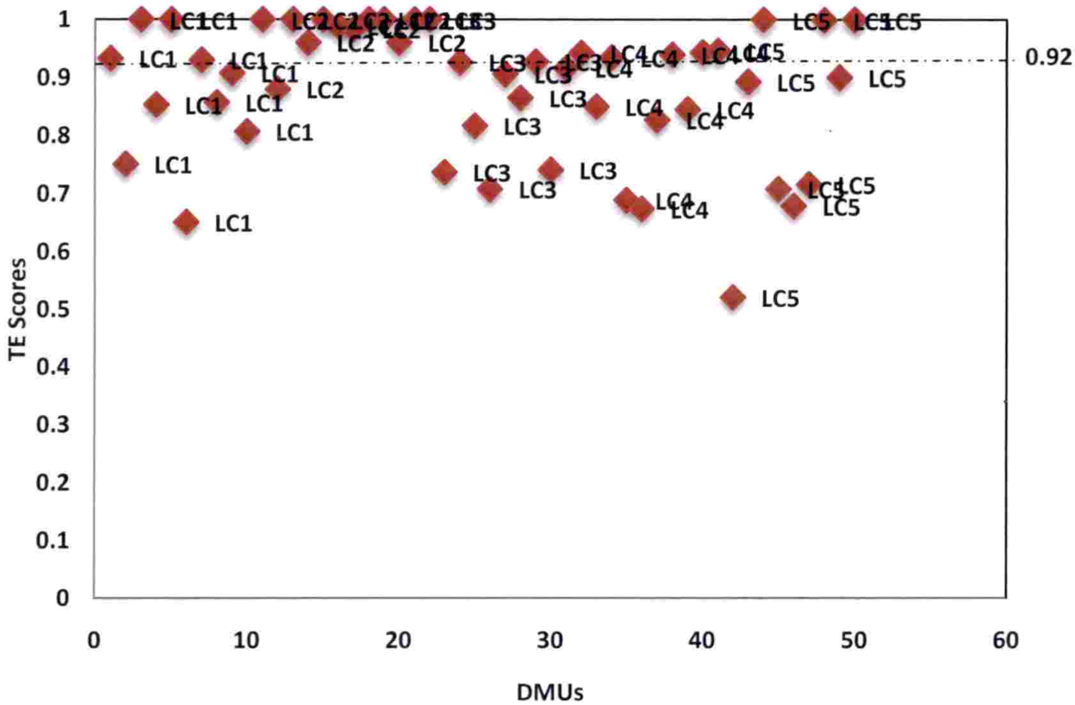

Fig. 4.8 Technical efficiency of producers in Ernakulum district

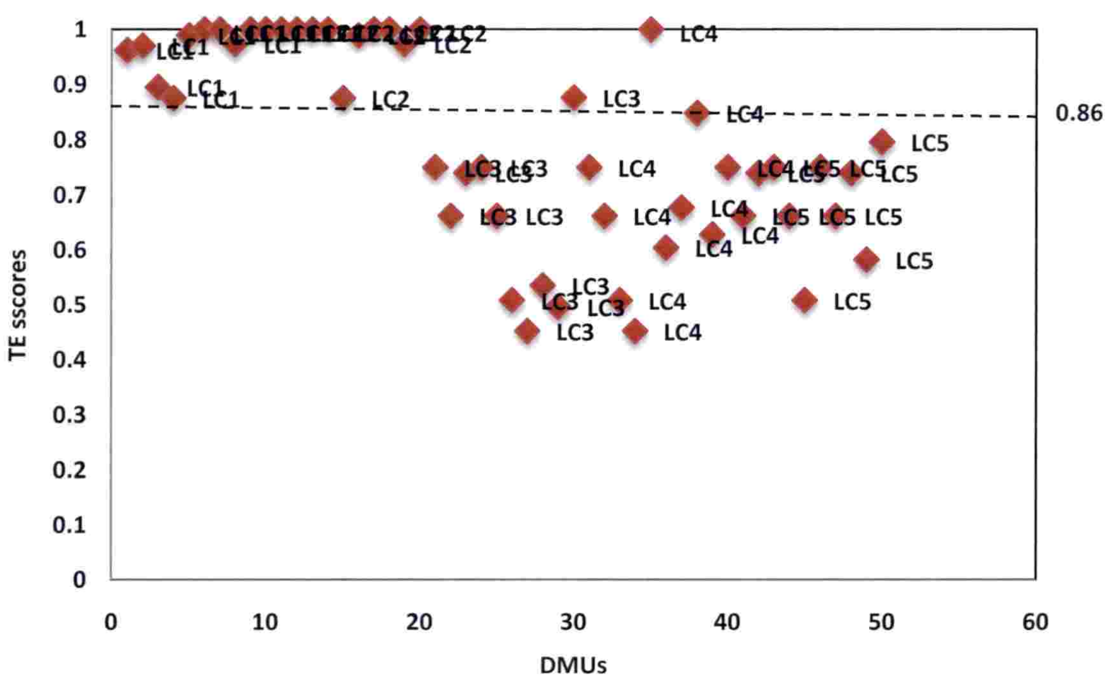

Fig. 4.9 Technical efficiency of producers in Kollam district

DMUs – Decision making units; TE – Technical efficiency

While the overall average revenue of producers at Kollam was Rs.0.17 lakhs, it ranged between Rs. 0.12 to Rs. 0.26 lakhs. The average working hours per day and working days per year was five and 330 respectively. The producers marketing cost was Rs. 1217.54. The number of buyers visited per day was ranged between 32 to 60 (Table 4.9).

Table. 4.9. Input – output variables – Producers of Kollam district

Variables	LC1	LC2	LC3	LC4	LC5	Overall
Outputs						
ADR (Rs. lakh.)	0.23	0.26	0.13	0.12	0.12	0.17
Inputs						
Working hours /day	5.3	5.2	4.2	4.2	4.5	5.0
Working days /year	330	328	330	335	328.3	330.12
Marketing cost (Rs.)	1380.00	1490.20	1167.50	1015.00	1033	1217.54
Cold storage (dummy)	1.5	1.3	1.2	1.1	1.1	1.2
Water availability (dummy)	1.3	1.4	1.1	1.1	1	0-.2
No. of buyers	60	56	42	34	32	45

LC – Landing centre

**LC1-Neendakara, LC2 –Sakthikulakara, LC3-Thanganassery, LC4-Vady, LC5-Aayirumthengu*

The estimated cumulative mean technical efficiency of producers is 0.92 and 0.86 in Ernakulam and Kollam districts respectively. From the results, it was implied that producers could reach the full technical efficiency level by increasing their outputs by 8 and 14% with the present input levels in Ernakulam and Kollam district respectively. It was found that among the five landing centres studied in Ernakulam district, only one was efficient (LC2). The mean technical efficiency was 0.91, 0.88, 0.98 and 0.72 at LC1, LC3, LC4 and LC5 respectively (Table 4.10). Based on this, it could be seen that LC1, LC3 and LC4 were the most technically efficient primary markets, whereas the least efficient one was LC5.

The scale efficiency results showed that except LC2, others showed scale inefficiency. This implied that producers' were operating at sub-optimal economies of scale. Next to LC2, LC4 showed high technical efficiency due to the intervention of fishermen co-operative societies in regulating fish marketing activity and also contributed significantly to producers' performance. This was supported with the similar results by Jeyanthi *et al.,(*2016). The LC5 is relatively smaller in size, which does not result in economies of scale and resulted

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in inefficiency of DMUs. According to Iliyasu *et al*., (2016), the smaller the size of the unit will ultimately affect the operational efficiency. This is also attributed to volume of fish landings and marketed at the particular landing centre which is comparatively low in the LC5 (Bissa and Vyas, 2014). The absence of necessary infrastructure facilities such as cold storage facilities at the landing centres also added to their performance levels (Kumar *et al.*, 2008).

Table. 4.10 .Technical and scale efficiency of producers in the coastal districts

Producer	Technical efficiency	Scale efficiency
Ernakulam		
LC1	0.914	0.954
LC2	1.000	1.000
LC3	0.875	0.898
LC4	0.975	0.989
LC5	0.817	0.754
Cumulative mean = 0.92		
Kollam		
LC1	1.000	0.978
LC2	0.846	0.895
LC3	0.875	0.921
LC4	0.791	0.965
LC5	0.768	0.879
Cumulative mean = 0.86		

The cumulative mean technical efficiency of producers at the Kollam landing centres was 0.86. It was found that among the five landing centres studied in Kollam district, only one was efficient (LC1). The mean technical efficiency of producers' at landing centres ranged between 76 to 100%. The mean technical efficiency of LC2, LC3, LC4 and LC5 was 0.85, 0.86, 0.79 and 0.77 respectively (Tab.4.10). Based on this, it could be seen that LC2, LC3 and LC4 were the most technically efficient, whereas the least efficient was LC5. It was observed that all the DMUs studied showed scale inefficiency which implied that all the units operated at sub-optimal economies of scale.

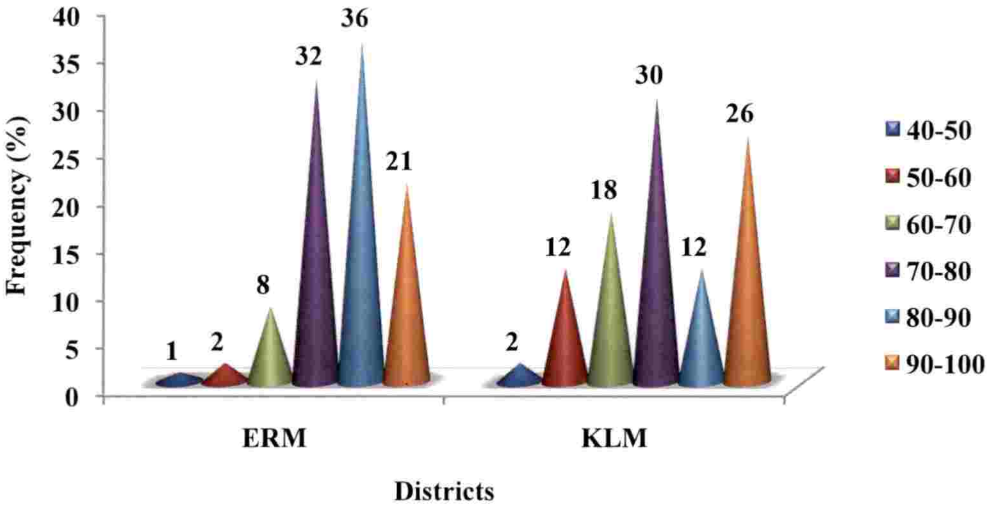

Fig.4.10 Performance of producers in coastal regions

** ERM – Ernakulam; KLM – Kollam*

Lack of infrastructure facilities such as cold storage facilities at the landing centres also added to their inefficient scale of operation. This mainly occurred during peak season when there is more fish supply and prices are comparatively low. The provision of adequate cold storage facilities will avoid distress sale and provide space for preservation and ultimately increase the profit of the producers.

The inter-district comparison of TE revealed that the cumulative mean technical efficiency of producers in Ernakulam is relatively better than Kollam district (fig.4.8). The TE score of DMUs showed that there were only 28% of units estimated below average efficiency levels in Ernakulam. There was aggregation of DMUs on the efficiency line (TE = 1) and many of the DMUs were approaching full efficiency. (Fig.4.9). The DMUs categorized into various efficiency levels revealed that in Ernakulam district, 40 and 36 per cent of respondents are in the efficiency levels of 80-90% and 70-80% respectively. While in Kollam, it was 14 and 34 per cent (Fig.4.10). Hence, it can be concluded that producers in Ernakulam are relatively more efficient than producers in Kollam district.

4.4.2 Performance of wholesalers in the fish marketing system

The wholesaler's performance was assessed using single output and seven inputs using DEA model. The average values of the variables used for assessing the wholesalers' performance were presented in table 4.11. The overall average daily revenue of wholesalers' in Ernakulum was Rs. 0.28 lakhs. The overall average working hours/day and working days/ year was 5.83 and 328 respectively. Marketing costs ranged between Rs.0.13 to Rs.14. The average number of buyers visited was 86 persons per day.

While, the overall ADR of wholesalers' at Kollam was Rs.0.34 lakhs, the range was Rs. 0.29 to Rs. 0.39 lakhs. The average marketing cost incurred by the wholesalers was Rs. 0.14 lakhs. And, the number of buyers visited varied between 70 to 75 per day (Table. 4.12).

Table 4.11. Input – output variables – wholesalers in Ernakulam district

Variables	W1	W2	W3	Overall
Outputs				
ADR (Rs.lakhs)	0.30	0.26	0.29	0.28
Inputs				
Working hours /day	5.90	5.90	5.70	5.83
Working days /year	334	322	327	328
Marketing cost (Rs.)	0.14	0.13	0.14	0.14
Cold storage	2	1.9	2	2
Drinking water	2	1.8	1.9	1.9
Transportation	2	2	2	2
No. of traders	91.5	77.3	88	85.6

W – Wholesale markets

** W1 – wholesale market 1; W2 – wholesale market 2; W3 – wholesale market 3*

Table 4.12. Input – output variables – wholesalers in Kollam district

Variables	W1	W2	W3	Overall
Outputs				
ADR (Rs. lakhs)	0. 29	0.39	0.31	0.33
Inputs				
Working hours /day	5.9	5.8	5.7	5.8
Working days /year	311.2	314	312	312.4
Marketing cost (Rs. lakhs)	0.13	0.13	0.13	0.13
Cold storage	1.8	1.8	1.8	1.8
Drinking water	1.6	1.6	1.6	1.6
Transportation	2	2	2	2
No. of traders	70.1	73.1	74.6	72.6

W – Wholesale markets

** W1 – wholesale market 1; W2 – wholesale market 2; W3 – wholesale market 3*

The average of the variables used in DEA model for assessing the wholesalers' performance in Idukki is presented in table.4.13. The overall ADR of Wholesalers' at the selected landing centres at Idukki was Rs. 0. 16 lakhs. The overall average working hours per day and working days/ year were six and 307.07 respectively. Marketing costs ranged between Rs.0.13 to Rs.0.14 lakhs. The average number of buyers visited per day was 71.

Table.4.13 .Input – output variables - wholesalers at Idukki district

Variables	W1	W2	W3	Overall
Outputs				
ADR (Rs.lakhs)	0.14	0.19	0.15	0.16
Inputs				
Working hours	6.00	5.80	6.10	5.97
Working days	305.70	314.00	301.50	307.07
Marketing costs	0.14	0.13	0.15	0.14
Cold storage	1.00	1.10	1.10	1.07
Drinking water	1.00	1.10	1.10	1.07
Transportation	1.00	2.00	1.10	1.37
No. of buyers	69.80	73.10	70.50	71.13

W – Wholesale markets

** W1 – wholesale market 1; W2 – wholesale market 2; W3 – wholesale market 3*

While, the overall average revenue of wholesalers' at Pathanamthitta was Rs.0. 20 lakhs within the range of Rs. 0.19 to Rs. 0.22 lakhs. The overall average working hours per day and working days per year were six and 313.87 respectively. The wholesalers' incurred marketing cost for marketing their fish which amounted Rs. 0.13 lakhs and the number of buyers visited per day varied between 70 to 73 (table 4.14).

Table. 4.14 .Input – output variables - wholesalers of Pathanamthitta district

Variables	W1	W2	W3	Overall
Outputs				
ADR (Rs.lakhs)	0.22	0.20	0.19	0.20
Inputs				
Working hours	6	5.9	6.2	6.03
Working days	305.7	320.2	315.7	313.87
Marketing costs	0.14	0.13	0.14	0.13
Cold storage	1	1.1	1	1.03
Drinking water	1	1.1	1	1.03
Transportation	1	2	1	1.33
No. of traders	70	73	71	71

W – Wholesale market

* W1 – Wholesale market 1; W2 – Wholesale market 2; W3 – Wholesale market 3

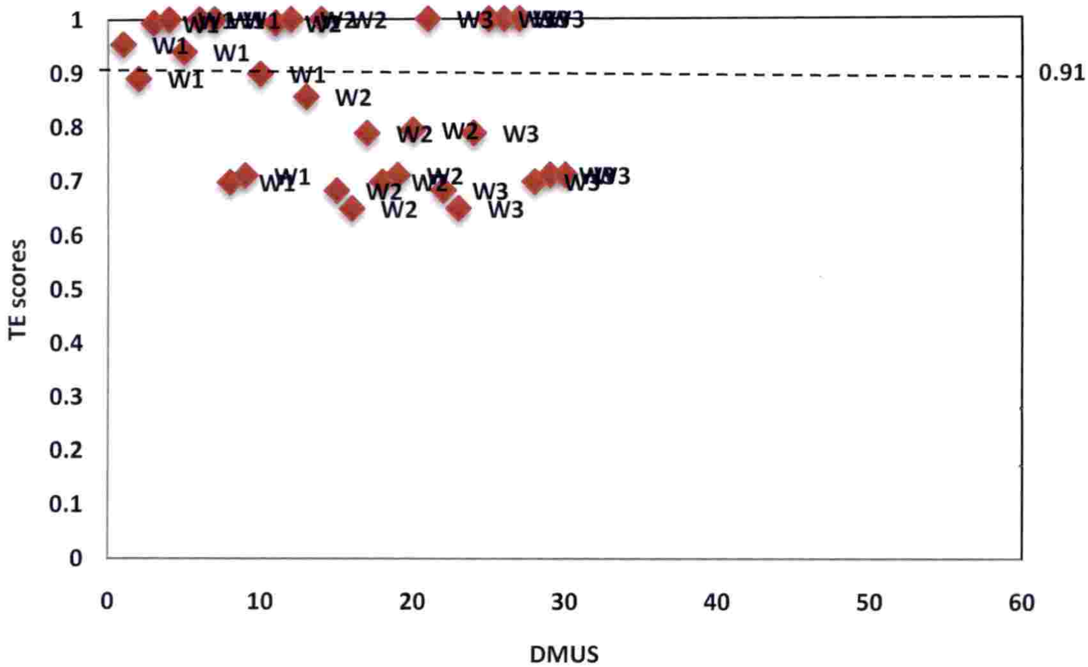

Fig.4.11 Technical efficiency of wholesalers in Ernakulum district

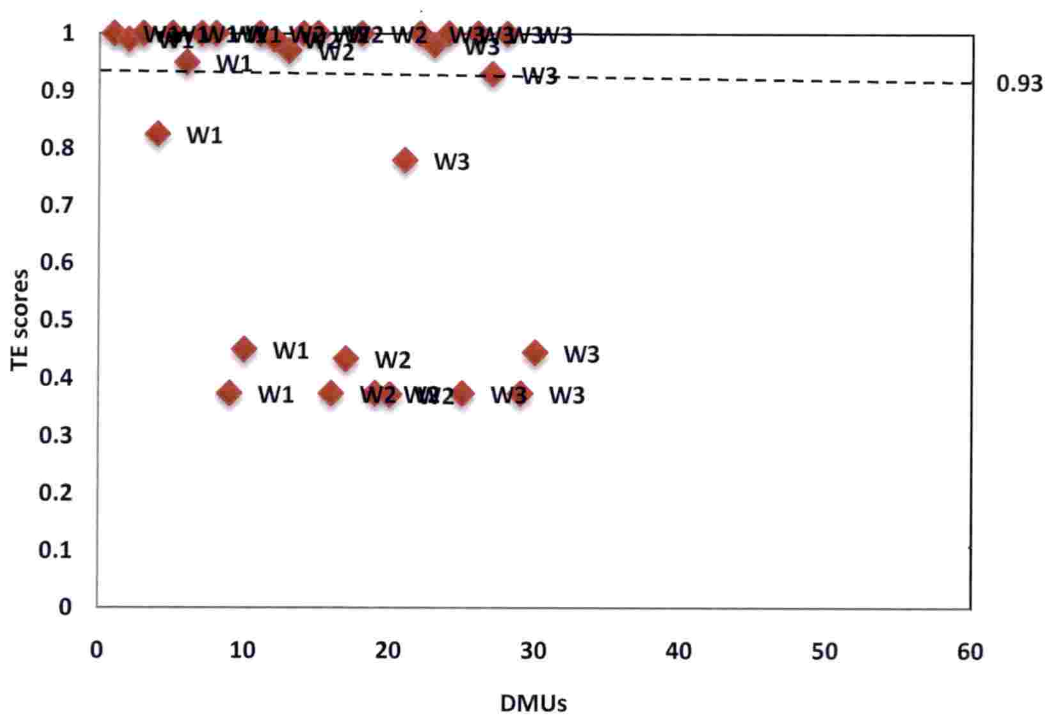

Fig.4.12 Technical efficiency of wholesalers in Kollam district

** DMUs – Decision making units; TE – Technical efficiency*

From the DEA results of wholesalers, it could be seen that the estimated cumulative mean technical efficiency of wholesalers was 0.91, 0.93, 0.62 and 0.81 in Ernakulam, Kollam, Idukki and Pathanamthitta districts respectively (Table 4.15). This implied that wholesalers could reach their full technical efficiency by increasing their outputs by 9, 7, 38 and 19 per cent with the present input levels in Ernakulam, Kollam, Idukki and Pathanamthitta districts respectively (Fig.4.11, 4.12, 4.13 & 4.14).

In the four districts studied, not one wholesale market showed full efficiency though in coastal districts (in Ernakulam and Kollam) markets showed very high technical efficiency i.e., above 0.80. This TE categorization was used by Aisyah *et al.,* 2012 while determining the factors influencing the technical efficiency levels of inshore fisheries in Malaysia.

Table. 4.15. Mean efficiencies of selected wholesalers in Kerala

Markets	Technical efficiency	Scale efficiency
Ernakulam		
W1	0.85	1.00
W2	0.81	0.84
W3	0.85	0.85
Cumulative mean = 0.91		
Kollam		
W1	0.85	0.89
W2	0.96	1.00
W3	0.87	0.91
Cumulative mean = 0.93		
Idukki		
W1	0.63	0.72
W2	0.71	0.82
W3	0.61	0.63
Cumulative mean = 0.62		
Pathanamthitta		
W1	0.87	0.84
W2	0.61	0.62
W3	0.73	0.75
Cumulative mean = 0.81		

W – Wholesale market

* W1 – Wholesale market 1; W2 – Wholesale market 2; W3 – Wholesale market 3

Among the markets, the technical efficiency of wholesalers in Idukki and Pathanamthitta were relatively low (Table 4.15) and Idukki wholesale markets showed least efficiency (Iliyasu *et al.*, 2016).

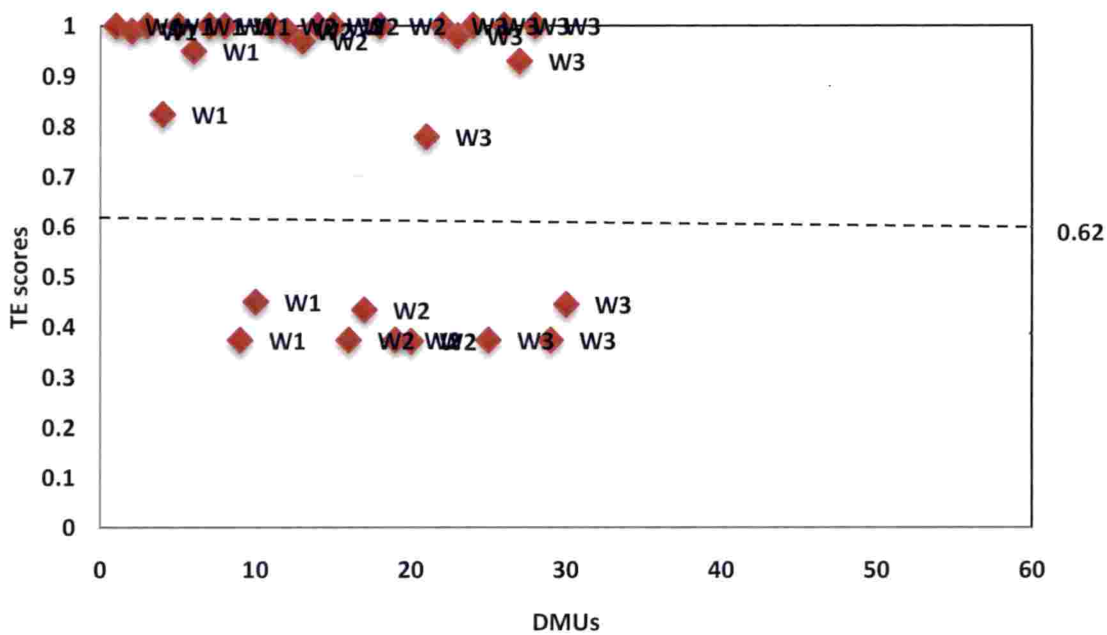

Fig.4.13 Technical efficiency of wholesalers in Idukki district

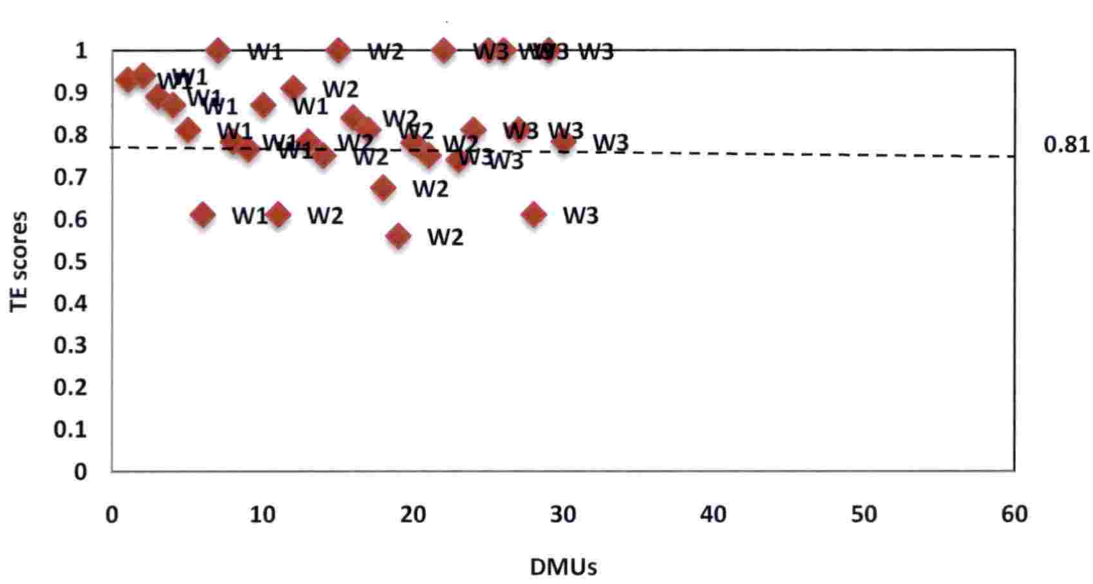

Fig.4.14 Technical efficiency of wholesalers in Pathanamthitta district

** DMUs – Decision making units; TE – Technical efficiency*

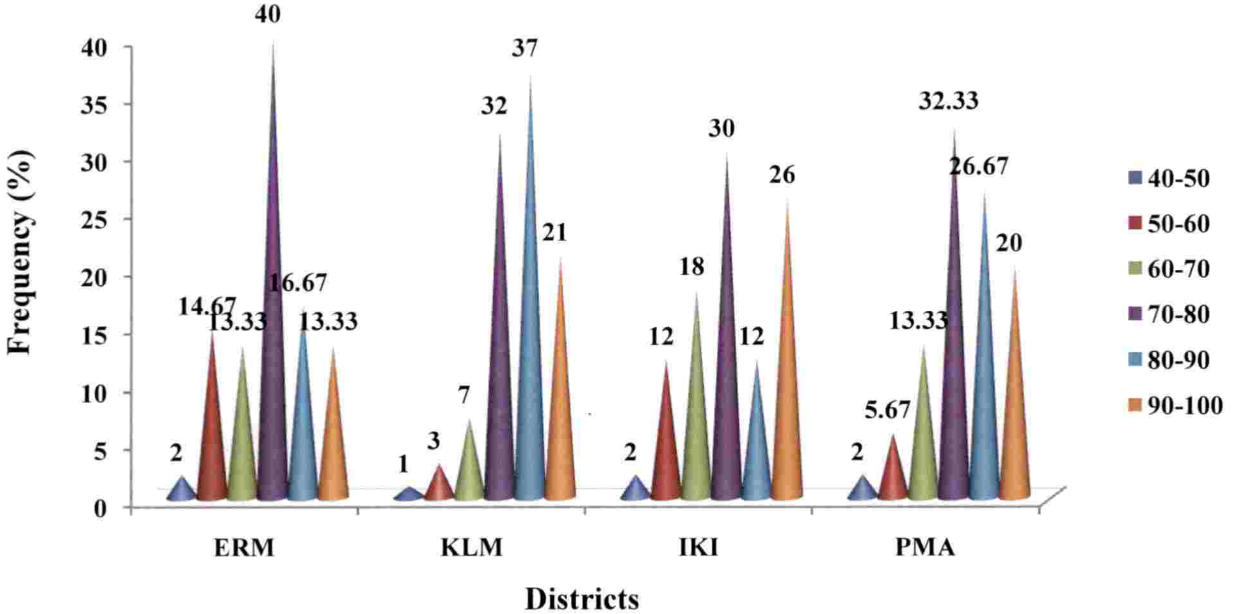

Fig.4.15 Performance of wholesalers in the selected districts

** ERM – Ernakulam; KLM – Kollam; IKI – Idukki; PNA - Pathanamthitta*

From this result, it was revealed that the markets in the coastal regions showed relatively high technical efficiency than the land locked regions (fig.4.15). From this, it was observed that there was apparent regional variation in the technical efficiencies of wholesalers.

In Ernakulam and Kollam, one market each i.e., E-W1 and K_W2 showed scale efficiency. The scale efficiency results showed that in majority of wholesale markets, the nature of inefficiency among the wholesalers was due to scale, as they were operated at sub-optimal economies of scale. This is mainly due to lack of infrastructure facilities such as cold storage facilities, which was added to their inefficient scale of operation (Kumar *et al.,* 2008). Many of them were not able to realize their optimum profit levels due to lack of basic marketing facilities at markets. Hence, the improvement in infrastructure facilities at the markets is highlighted towards enhancing the technical efficiency.

The DMUs are categorized into various efficiency levels, which revealed that 40, 32, 30 and 32 percent of respondents were in the efficiency level of 70-80% in Ernakulam, Kollam, Idukki and Pathanamthitta district respectively. In Kollam, majority belonged to 80 – 90% efficiency level (37%). (Fig.. The inter-district comparison of TE showed that the wholesalers in Kollam district were comparatively high followed by wholesalers in Ernakulam district. The wholesalers in Idukki were the least efficient. It could be due to low experience of wholesalers in Idukki than other districts. This was accepted by Lem *et al.,* (2004) that long experience of sellers resulted in good awareness about marketing related aspects.

4.4.3 Performance of retailers in the fish marketing system

Retailers are the sellers who transact less volume of fish than wholesalers. To assess the retailers' performance in two coastal (Ernakulam and Kollam) and two land locked (Idukki and Pathanamthitta) districts, single output and seven input variables were used for the DEA model. The average details of the variables selected for assessing the wholesalers' performance using DEA model were presented in table 4.16.

The overall average revenue of retailers' at Ernakulum was Rs. 0.31 lakhs. The overall average working hours and working days/ year were 5.73 and 325 respectively. Marketing costs ranged between Rs.12195 to Rs.12645. The average number of buyers visited per day is 57. While, the overall average revenue of retailers' at Kollam was Rs.0. 32 lakhs and falls within the range of Rs. 28,967.60 to Rs. 35868.60. The overall average working hours and working days/ year were 6 and 333 respectively. The retailers marketing cost was Rs. 14016. 67. And, the number of buyerswho visited the market per day is varied between 76 to 88. (Table 4.17).

Table.4.16.Input – Output variables - retailers in Ernakulam district

Variables	R1	R2	R3	Overall
Outputs				
ADR (Rs.lakhs)	0.35	0.32	0.27	0.31
Inputs				
Working hours /day	5.8	5.6	5.7	5.73
Working days /year	322.7	333	319	324.9
Marketing cost (Rs.)	12645	12450	12195	12430
Cold storage	11.9	1.9	1.8	1.87
Drinking water	1.8	1.9	1.8	1.83
Transportation	2	2	2	2
No. of traders	58	56	57	57

R – Retailer market

** R1 – Retail market 1; R2 – Retail market 2; R3 – Retail market 3*

Table.4.17.Input – Output variables – retailers in Kollam, Kerala

Variables	R1	R2	R3	Overall
Outputs				
ADR (Rs. lakhs)	0.36	0.32	0.29	0.32
Inputs				
Working hours /day	6.1	6	6.2	6.1
Working days /year	333.9	334.2	329.7	332.6
Marketing cost (Rs.)	13550	13900	14600	14016.67
Cold storage	2	2	2	2
Drinking water	2	2	2	2
Transportation	2	2	2	2
No. of traders	88	81	76	82

R – Retailer market

** R1 – Retail market 1; R2 – Retail market 2; R3 – Retail market 3*

The overall average revenue of retailers' at Idukki was Rs. 0.22 lakhs. The overall average working hours per day and working days/ year were 6 and 334 respectively. Marketing costs ranged between Rs.13550 to Rs.14700. There were 26 buyers visited daily. (Table 4.18).

Table.4.18. Input – output variables – retailers in Idukki district

Variables	R1	R2	R3	Overall
Outputs				
ADR (Rs. Lakhs)	0.22	0.23	0.20	0.22
Inputs				
Working hours	6.1	6.2	6.3	6.2
Working days	333.9	333.7	333	333.53
Marketing costs	13550	14200	14700	14150
Cold storage	2	2	2	2
Drinking water	2	2	2	2
Transportation	2	2	2	2
No. of buyers	28.6	24.9	24	25.83

R – Retailer market

** R1 – Retail market 1; R2 – Retail market 2; R3 – Retail market 3*

Table 4.19. Input – output variables - retailers in Pathanamthitta district

Variables	R1	R2	R3	Overall
Outputs				
ADR (Rs. Lakhs)	0.19	0.12	0.18	0.16
Inputs				
Working hours	6	6.2	6.1	6
Working days	330	334	333	332
Marketing costs	13650	14200	14150	14000
Cold storage	2	2	2	2
Drinking water	2	2	2	2
Transportation	2	2	2	2
No. of buyers	25	25	24	24

R – Retailer market

** R1 – Retail market 1; R2 – Retail market 2; R3 – Retail market 3*

While, the overall average revenue of retailers' at Pathanamthitta was Rs.0.16 lakhs within the range of Rs.0.12 to Rs. 0.18 lakhs. The overall average working hours and working days/ year were 6 and 332 respectively he producers marketing cost was Rs. 14000. And, the number of buyers visited varied between 22 to 24 per day (Table 4.19).

The DEA results of retailers at Ernakulam, Kollam, Idukki and Pathanamthitta district in Kerala are presented in Table.4.20. From the DEA results, it could be seen that the estimated mean technical efficiencies of the retailers was 0.87, 0.81, 0.72 and 0.78 in Ernakulam, Kollam, Idukki and Pathanamthitta districts respectively.

This implied that retailers could reach the full technical efficiency by increasing their outputs by 13, 19, 28 and 22% with the present input levels in Ernakulam, Kollam, Idukki and Pathnamthitta districts respectively.

The cumulative mean technical efficiencies of retailers were 0.78, 0.81, 0.63 and 0.74 at Ernakulam, Kollam, Idukki and Pathanamthitta districts respectively. It was observed that only one retail market showed high efficiency (R1: 0.90) in Ernakulam and Pathanamthitta (R1: 0.83). In Kollam district, two markets showed high efficiency (R1: 0.90 & R2: 0.80) and all other markets showed below 0.80 (Aisyah *et al.,* 2012). Among the markets, the technical efficiency in Idukki and Pathanamthitta are relatively low (Table 4.20) and Idukki retail markets showed least efficiency (Iliyasu *et al.*, 2016).

Based on the cumulative average efficiency scores, the retailers in Kollam showed high technical efficient followed by Ernakulam, Pathanamthitta and Idukki districts (Fig.4.16, 4.17, 4.18 & 4.19).

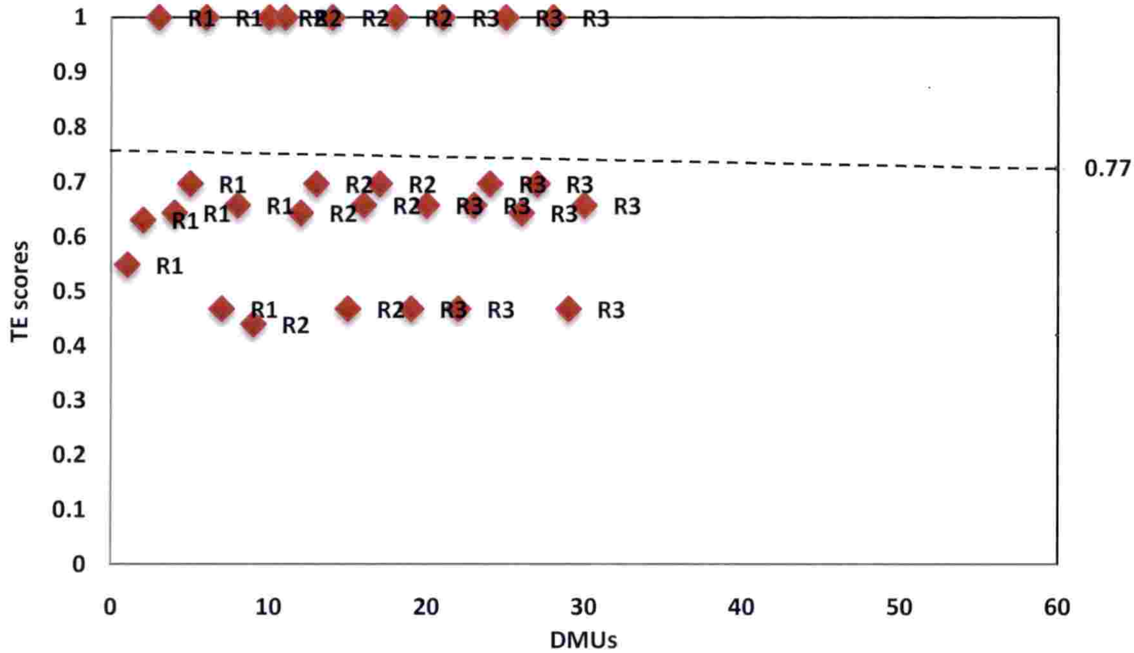

Fig.4.16 Technical efficiency of retailers in Ernakulum district

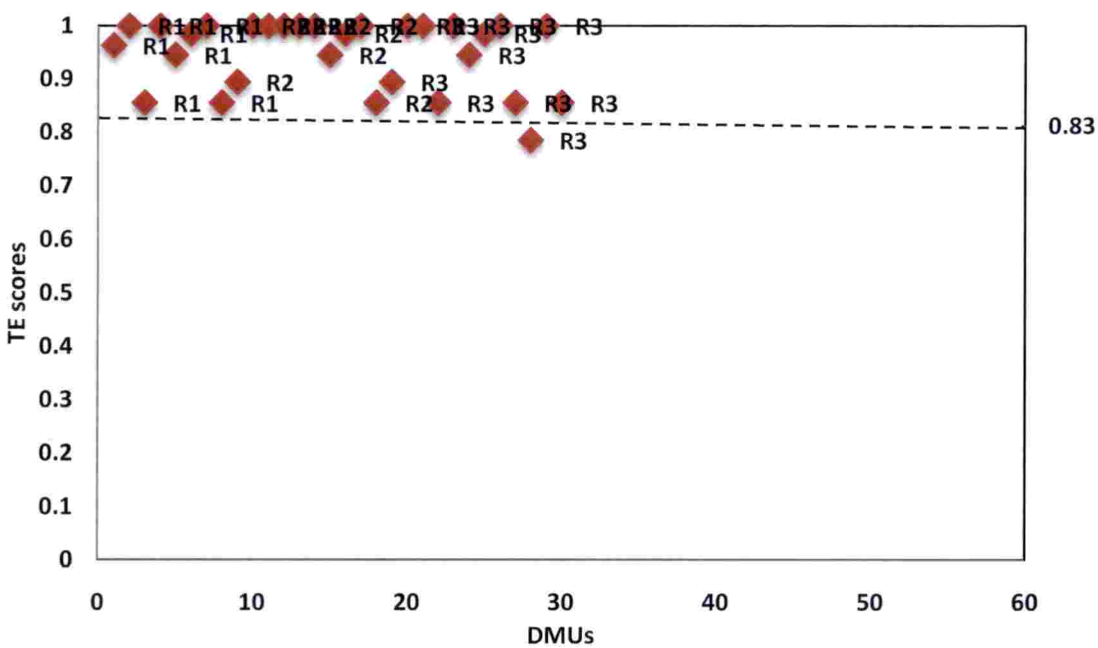

Fig. 4.17 Technical efficiency of retailers in Kollam district

**** DMUs – Decision making units; TE – Technical efficiency***

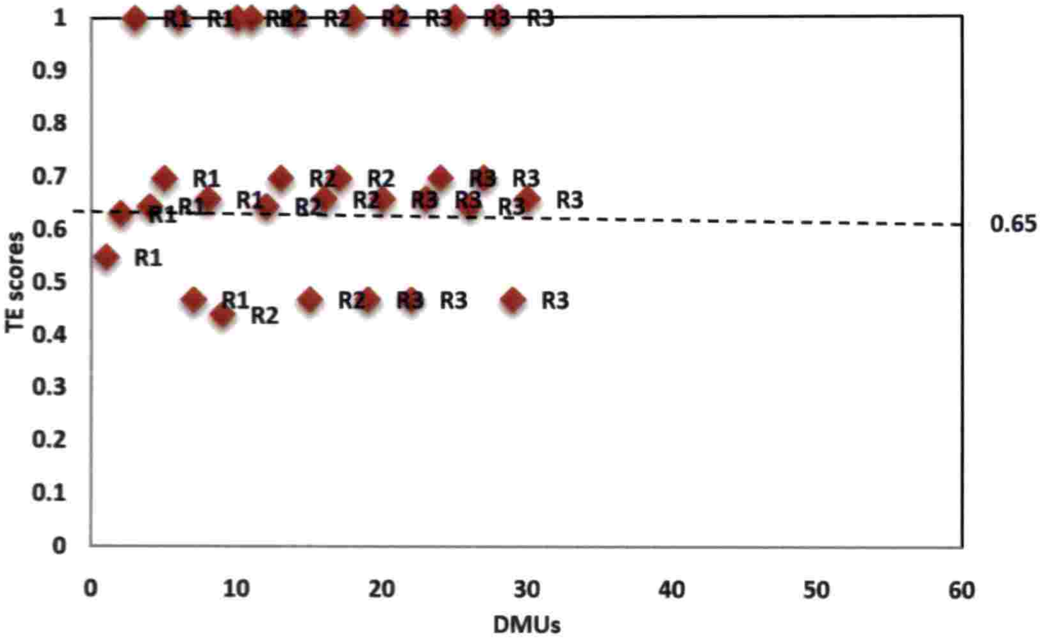

Fig.4.18 Technical efficiency of retailers in Idukki district

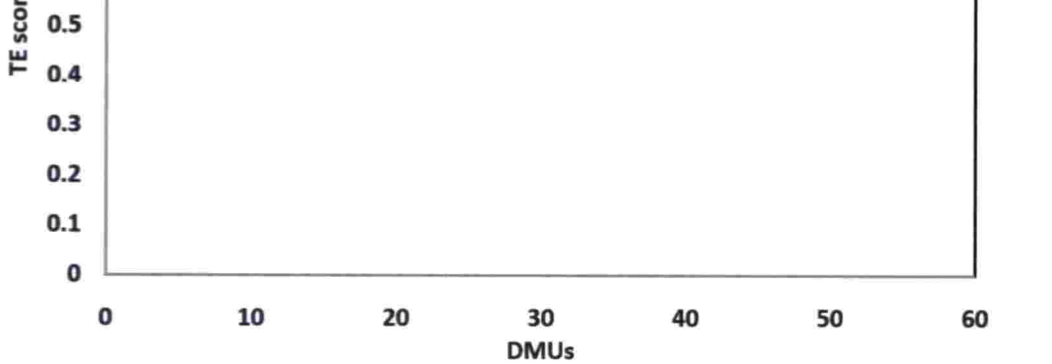

Fig. 4.19 Technical efficiency of retailers in Pathanamthtitta district

DMUs – Decision making units; TE – Technical efficiency

Table. 4.20. Mean efficiencies of selected retailers in Kerala

Markets	Technical efficiency	Scale efficiency
Ernakulam		
R1	0.89	1.00
R2	0.79	0.95
R3	0.68	0.95
Cumulative mean =0.77		
Kollam		
R1	0.91	0.96
R2	0.83	0.82
R3	0.72	0.79
Cumulative mean = 0.83		
Idukki		
R1	0.65	0.69
R2	0.63	0.69
R3	0.75	0.77
Cumulative mean = 0.65		
Pathanamthitta		
R1	0.87	0.90
R2	0.69	0.79
R3	0.66	0.80
Cumulative mean = 0.73		

** R1 – Retail market 1; R2 – Retail market 2; R3 – Retail market 3*

From this result, it was revealed that the markets in the coastal regions showed relatively high technical efficiency than the markets in land locked regions. There is regional variation in technical efficiency scores of retailers at the coastal and landlocked regions. It was found that in all the districts, majority of the retailers (33%) have been found to have 70-80% efficiency levels with Kollam (36%), Ernakulam (33%) and Pathanamthitta (33%) and Idukki, 30% DMUs being in the 70-80 % efficiency level (Fig.4.20).

The mean technical efficiency and mean potential to increase technical efficiency of the market functionaries in coastal and landlocked regions is presented in table.4.21. From the technical efficiency scores, it was observed that there is potential to increase the efficiency of market functionaries. The MPTE showed that the retailers showed high potential towards increasing the technical efficiency. Comparatively, wholesalers in coastal districts performed well than land locked district with more scope to increase technical efficiency. It was 38 and 29 % potential increase from the present level of efficiency at Idukki and Pathanamthitta respectively. The same at retailers was 35 and 27 % potential increase in TE in Idukki and Pathanamthitta respectively.

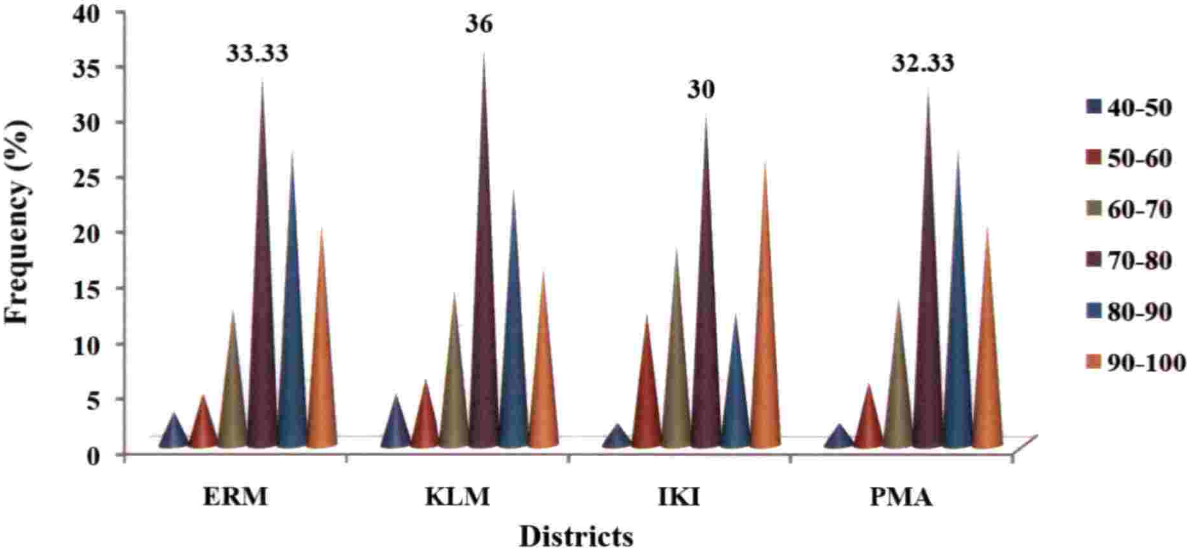

Fig.4.20 Performance of retailers in the selected districts

**** ERM – Ernakulam; KLM – Kollam; IKI – Idukki; PNA - Pathanamthitta***

The producers at Kollam, wholesalers and retailers at Idukki showed high potential towards increasing the technical efficiency.

Table.4.21 . Possibility to increase technical efficiency in the selected domestic fish markets in Kerala

Districts	Producers		Wholesalers		Retailers	
	MTE	MPTE	MTE	MPTE	MTE	MPTE
Coastal						
Ernakulam	0.92	0.08	0.91	0.09	0.77	0.23
Kollam	0.86	0.14	0.93	0.07	0.88	0.12
Land locked						
Idukki	-	-	0.62	0.38	0.65	0.35
Pathanamthitta	-	-	0.81	0.29	0.73	0.27

MTE – Mean Technical Efficiency
MPTE – Mean Potential to increase Technical Efficiency

4.4.4. Factors influencing the technical efficiency of various market functionaries

The factors influencing the technical efficiency of producers, wholesalers and retailers in the selected districts were analyzed using stochastic frontier production function (SFPF). The results of SFPF for the producers, wholesalers and retailers in Ernakulam, Kollam, Idukki and Pathanamthitta are discussed.

The parameter gamma (γ) value varies between 0.905 to 0.983 and was significant at 1% level. This implied that the composite error term was mainly explained by the technical efficiency alone, i.e., the change in input combinations will result in improving the technical efficiency of market functionaries (Tab. 4.22). The parameters viz., marketing costs and cold storage facilities in coastal districts and marketing costs, working hours per day, working days per year, water availability and transportation in land locked districts showed significant and were the factors determining the technical efficiency (TE).

The results showed that in all the markets studied, marketing cost showed negative sign but contributed significantly. This implied that increase in marketing cost will reduce the technical efficiency which is more influenced in Idukki wholesalers (38.9%) and retailers (128.4%). In Ernakulam and Kollam, the lack of cold storage facility at landing centres showed adverse impact on efficiency scores. The lack of transportation facility had negative significant impact on efficiency in Idukki district. And also the average daily revenue is correlated with technical efficiency. The quantum of sales could significantly contribute to the higher technical efficiency levels as explained by Ly *et al.,* 2016.

In general, average daily revenue of the producers, wholesalers and retailers showed positive and significant influence on technical efficiency. The marketing costs were having negative significant effects on technical efficiency of wholesalers and retailers. About 1% increase in marketing cost will reduce the technical efficiency by 0.34 and 0.39% at wholesalers at Kollam and Idukki respectively. But in Idukki retailers' level, it was more than 1% decrease in the efficiency due to the geographical location and lack of transportation facilities in these land locked regions. There is scope for increasing the TE levels through decreasing the input costs and utilizing low cost technologies. In marketing the improvement in infrastructure will enhance their technical efficiency by increasing the scale of operation. Similar result were obtained by Aisyah *et al.,* 2012.

Table.4.22. Parameter estimation using SFPF model

Variables	Parameter	Producers		Wholesalers				Retailers			
		ERM	KLM	ERM	KLM	IDI	PTA	ERM	KLM	IDI	PTA
Constant	β_0	0.194	0.219	0.375	0.612	0.142	0.129	0.251	0.154	0.452	0.124
		(0.317)	(0.167)	(0.130)	(0.243)	(0.056)	(0.054)	(0.087)	(0.013)	(0.091)	(0.034)
Working hours/ day	B_1	0.361	0.294	0.264	0.124	0.364**	0.266	0.025	0.051	0.218*	0.106
		(0.015)	(0.002)	(0.085)	(0.016)	(0.547)	(0.035)	(0.375)	(0.060)	(0.075)	(0.034)
Working days/ year	β_2	0.051	0.117	0.125	0.034	0.221*	0.125	0.354	0.025	1.786*	0.113
		(0.003)	(0.010)	(0.1103)	(0.016)	(0.011)	(0.521)	(0.086)	(0.012)	(0.539)	(0.038)
Marketing cost	β_3	-0.121*	-0.031*	-0.197**	-0.342**	-0.389**	-1.124	-0.248*	-0.675	-1.284**	-0.251
		(0.054)	(0.023)	(0.012)	(0.289)	(0.024)	(0.483)	(0.049)	(0.129)	(0.047)	(0.095)
Cold storage facility	β_4	0.128**	0.150*	0.086	0.145	0.214	0.101	0.005	1.245	0.035	0.005
		(0.101)	(0.053)	(0.058)	(0.067)	(0.106)	(0.111)	(0.001)	(0.094)	(0.045)	(0.001)
Water availability	β_5	0.137	0.217	0.056	0.022	0.223*	0.123	0.243	0.129	0.254**	0.175
		(0.016)	(0.109)	(0.002)	(0.018)	(0.112)	(0.042)	(0.154)	(0.030)	(0.085)	(0.032)
Transportation	β_6			0.128	0.025	0.215*	0.125	-0.048	0.132	0.248**	0.184
		-	-	(0.003)	(0.015)	(0.043)	(0.032)	(0.003)	(0.074)	(0.067)	(0.065)
No. of buyers	β_7	0.218	0.338	0.214	0.245	0.327	0.254	0.315	0.341	0.623	1.594
		(0.105)	(0.006)	(0.132)	(0.143)	(0.187)	(0.097)	(0.056)	(0.152)	(0.317)	(0.169)
gamma (γ)		0.978	0.983	0.964	0.953	0.914	0.947	0.974	0.960	0.905	0.936
R^2		0.68	0.70	0.74	0.65	0.61	0.64	0.70	0.68	0.69	0.71
F-value		1.872	1.657	3.701	2.365	1.875	2.457	1.957	2.125	1.325	1.854

Figure in parentheses indicate the standard error
*** - Significant at 1% level; * - Significant at 5% level.*

4.5. Price transmission and market integration of fish

Price is most decisive factor of consumer purchase of particular commodity. The linkages between markets are an important area of marketing research in deciding their competitiveness. In developing countries, studies on these lines are comparatively limited due to lack of time series data across species, markets and along the supply chain. The concept of price integration between markets would be a possible solution towards addressing the supply-side constraints. In marketing research, price dynamics and transformation of price from the producers to consumers is important for price formation (Garica and Salayo, 2009,). The average wholesale prices of four each under High Value Fishes (HVF) and Low Value Fishes (LVF) are presented in table 4.23.

The average daily wholesale price of HVFs viz., seerfish, shrimp, pomfret and tuna in the selected markets ranged between Rs. 385.27 -Rs. 409.61, Rs. 373.14 - Rs.400.96,Rs. 402.69 and Rs. 426.54 -Rs. 132.69 - 156.73 respectively. The average daily wholesale price of LVFs varied between Rs. 83,82 and Rs.88.08 (sardine), Rs. 131.73 and 144.42 (mackerel), Rs. 149.33 and 175.77 (anchovies) and Rs. 150.19 and Rs. 157.65 (thread fin bream). The average daily wholesale price of fish was Rs. 244.15 and Rs. 227.15.

The average daily retail price of HVFs viz.., seerfish, shrimp, pomfret and tuna in the selected markets ranged between Rs. 705.29 and Rs. 851.76, Rs. 450.60 and Rs.490.24, Rs. 416.35 and Rs. 625.96 and Rs. 216.35 and 264.73 respectively. The average weekly retail price of LVFs varied between Rs. 128.46 and Rs.156.73 (sardine), Rs. 207.12 and 229.81 (mackerel), Rs. 169.23 and 183.90 (anchovies) and Rs. 183.85 and Rs. 199.23 (thread fin bream). The average daily retail price of fish was Rs. 324.63 and Rs. 374.78 (Table 4.24).

From the table, it was revealed that pomfret was the costliest (Rs. 416.54/kg) fish among the species studied among the HVFs studied in terms of wholesale prices. This was followed by seerfish (Rs.397.79/ kg), shrimp (Rs.386.05) and (Rs.146.04) based on wholesale prices. Similarly, in the LVFs, Anchovies was costliest (Rs. 161.47/kg). Based on retail prices, seerfish (Rs. 751.37/kg) and mackerel were the costlier fish under HVF and LVF category. In general, the wholesale price is mainly of supply-driven, while the retail price is demand-driven (Garcia and Salayo, 2009). And it was found that there are variation in fish prices between species, markets and regions.

Table 4.23. Average daily wholesale prices of HVF and LVF fishes in the selected markets in Kerala during 2016-17

Market	High Value Fishes (HVF)				Low Value Fishes (LVF)			
	Seerfish	Shrimp	Pomfret	Tuna	Sardine	Mackerel	Anchovies	Thread Fin Bream
E-W1	393.14	389.23	409.42	132.69	83.82	131.73	151.92	150.19
E-W2	386.27	373.46	403.27	137.00	85.19	132.50	149.23	152.12
E-W3	385.29	373.14	402.69	136.69	84.80	135.58	149.62	152.12
K-W1	400.59	391.15	416.92	134.04	84.71	135.00	147.69	150.38
K-W2	385.49	382.31	409.42	137.50	86.25	132.88	152.69	152.50
K-W3	385.88	377.69	408.27	137.88	85.67	136.73	148.85	151.35
I-W1	409.61	400.96	426.54	155.96	88.08	140.77	173.75	157.65
I-W2	407.45	396.54	420.96	156.35	86.54	143.65	175.77	154.62
I-W3	403.73	385.19	424.62	156.15	85.58	144.42	176.54	153.27
P-W1	407.84	391.73	425.38	156.73	84.81	141.54	173.08	140.00
P-W2	404.51	389.81	424.23	155.19	87.02	142.50	172.50	156.06
P-W3	403.73	381.35	420.38	156.35	85.00	143.08	165.96	153.27

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Table 4.24. Average daily retail prices of HVF and LVF fishes in the selected markets in Kerala during 2016-17

Market	High Value Fishes (HVF)				Low Value Fishes (LVF)			
	Seerfish	Shrimp	Pomfret	Tuna	Sardine	Mackerel	Anchovies	Thread Fin Bream
E-R1	705.29	450.60	517.31	227.88	128.46	207.12	175.19	185.19
E-R2	708.63	473.25	553.85	229.62	129.62	208.46	171.92	187.31
E-R3	711.96	474.59	533.65	216.35	131.15	209.42	169.23	188.65
K-R1	703.06	461.34	516.35	227.50	130.00	208.27	172.88	183.85
K-R2	706.27	482.45	549.52	227.12	131.15	208.85	170.58	189.23
K-R3	710.59	477.97	539.42	226.73	131.54	192.88	169.23	187.50
I-R1	840.98	489.53	621.15	264.42	155.00	229.62	183.90	198.08
I-R2	850.98	490.24	625.96	265.19	154.81	229.81	182.02	199.23
I-R3	851.76	485.67	622.12	265.58	156.73	229.23	182.12	194.62
P-R1	737.06	461.71	574.52	227.88	139.81	214.04	179.04	189.23
P-R2	738.24	475.67	589.90	226.73	138.65	211.35	180.96	190.19
P-R3	751.57	437.62	572.12	225.96	142.31	219.04	180.58	189.81

4.5.1 Co-integration between markets (Horizontal integration)

Horizontal (spatial) price integration refers to co-integration of prices in a given market at two price levels i.e., wholesale and retail levels.

The Augmented Dickey Fuller (ADF) unit root test was used for stationarity test of the price series. The results showed that the price series of the four high value and low value fishes at wholesale and retail markets studied were stationary both at their first differenced series [at I(1)] (Tab.4.25 & Tab. 4.26).

In all the markets, the ADF t-statistic was greater than the critical levels. Hence, the null hypothesis of non-stationarity was rejected at first difference for all the markets studied in Ernakulam, Kollam, Idukki and Pathanamthitta districts. This substantiated with the findings of various authors that most of the food items are stationary at their first difference, i.e.,at I(1) (Alexander and Wyeth, 1994 and Mafimisebi, 2001). For all the markets, it is supporting the rule of co-integration. The market competition is largely influenced by the arrivals at landing centre that stabilises the price movements (Garcia and Salayo, 2009).

Table 4.25 Augmented Dickey Fuller (ADF) unit root test for the wholesale markets in the selected markets

Markets	HVF								LVF							
	Seerfish		Shrimp		Pomfret		Tuna		Sardine		Mackerel		Anchovies		Threadfin bream	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
E-W1	-1.73	-2.98**	-1.71	-7.71**	-4.57	-4.69**	-0.53	-3.64**	-2.39	-4.82**	-3.58	-5.84**	-0.12	-3.52**	-2.68	-3.18**
E-W2	-1.48	-3.45**	-1.91	-6.06**	-5.26	-5.54**	-0.35	-3.48**	-1.80	-5.01**	-3.38	-6.15**	-0.27	-4.82**	-1.43	-4.65**
E-W3	-1.46	-3.76**	-1.93	-6.82**	-3.98	-4.12**	-0.28	-1.57**	-2.25	-9.12**	-7.14	-9.72**	-0.35	-3.17**	-1.58	-4.16**
K-W1	-1.60	-4.06**	-1.45	-2.78**	-2.68	-2.85**	-0.34	-4.72**	-1.58	-7.31**	-3.05	-4.51**	-0.43	-3.46**	-1.58	-4.52**
K-W2	-2.68	-3.18**	-1.90	-5.76**	-3.48	-3.57**	-0.26	-4.51**	-2.78	-11.43**	-4.28	-5.95**	-0.63	-4.05**	-1.49	-4.45**
K-W3	-1.43	-4.65**	-1.90	-3.45**	-5.27	-5.40**	-0.12	-3.95**	-3.45	-11.38**	-3.06	-3.46**	-0.68	-5.38**	-1.58	-3.50**
I-W1	-1.58	-4.16**	-1.96	-4.26**	-3.58	-4.21**	-0.18	-3.46**	-0.80	-6.19**	-0.12	-4.05**	-0.39	-3.56**	-1.53	-2.62**
I-W2	-1.58	-4.52**	-2.07	-4.36**	-3.38	-3.87**	-0.57	-4.05**	-1.75	-7.45**	-0.18	-5.38**	-0.82	-4.26**	-3.58	-4.21**
I-W3	-1.49	-4.45**	-1.88	-4.41**	-7.14	-7.68**	-0.46	-5.38**	-1.42	-8.15**	-0.57	-6.17**	-0.40	-3.13**	-3.38	-3.87**
P-W1	-1.58	-3.50**	-1.89	-2.87**	-3.05	-3.12**	-0.48	-3.56**	-1.23	-9.17**	-0.46	-5.45**	-0.65	-4.15**	-7.14	-7.68**
P-W2	-1.53	-2.62**	-1.94	-4.31**	-4.28	-4.39**	-0.57	-4.26**	-1.80	-6.19**	-0.48	-2.95**	-0.26	-4.35**	-3.05	-3.12**
P-W3	-1.51	-4.55**	-1.98	-5.31**	-3.06	-3.49**	-0.47	-3.77**	-2.48	-6.12**	-0.29	-3.71**	-0.52	-2.61**	-4.28	-4.39**

Table 4.26 Augmented Dickey Fuller (ADF) unit root test for the retail markets in the selected markets

Markets	HVF								LVF							
	Seerfish		Shrimp		Pomfret		Tuna		Sardine		Mackerel		Anchovies		Threadfin bream	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
E-W1	-0.35	-3.48**	-1.90	-6.82**	-1.46	-3.76**	-0.43	-3.46**	-3.98	-4.12**	-1.80	-5.01**	-1.90	-3.45**	-1.75	-7.45**
E-W2	-0.28	-1.57**	-1.96	-2.78**	-1.60	-4.06**	-0.63	-4.05**	-2.68	-2.85**	-2.25	-9.12**	-1.96	-4.26**	-1.42	-8.15**
E-W3	-0.34	-4.72**	-2.07	-5.76**	-2.68	-3.18**	-0.68	-5.38**	-3.48	-3.57**	-1.58	-7.31**	-0.82	-4.26**	-1.23	-9.17**
K-W1	-0.26	-4.51**	-1.88	-3.45**	-1.58	-7.31**	-0.39	-3.56**	-5.27	-5.40**	-2.78	-11.43**	-0.35	-3.48**	-2.25	-9.12**
K-W2	-0.12	-3.95**	-1.89	-4.26**	-2.78	-11.43**	-0.82	-4.26**	-3.58	-4.21**	-3.45	-11.38**	-0.28	-1.57**	-1.58	-7.31**
K-W3	-0.18	-3.46**	-1.94	-4.36**	-3.45	-11.38**	-0.40	-3.13**	-3.38	-3.87**	-0.80	-6.19**	-0.34	-4.72**	-2.78	-11.43**
I-W1	-0.57	-4.05**	-3.58	-4.41**	-0.80	-6.19**	-0.65	-4.15**	-7.14	-7.68**	-1.75	-7.45**	-0.26	-4.51**	-3.45	-11.38**
I-W2	-0.46	-5.38**	-3.38	-2.87**	-1.75	-7.45**	-1.80	-5.01**	-1.58	-4.52**	-0.27	-4.82**	-0.12	-3.95**	-0.80	-6.19**
I-W3	-0.48	-3.56**	-7.14	-7.68**	-1.42	-8.15**	-2.25	-9.12**	-1.49	-4.45**	-0.35	-3.17**	-0.18	-3.46**	-1.90	-5.76**
P-W1	-0.35	-3.48**	-3.05	-3.12**	-1.58	-7.31**	-1.58	-7.31**	-1.58	-3.50**	-0.43	-3.46**	-0.46	-5.38**	-1.90	-3.45**
P-W2	-4.28	-4.39**	-4.28	-4.39**	-2.78	-11.43**	-2.78	-11.43**	-1.53	-2.62**	-0.63	-4.05**	-0.48	-3.56**	-1.45	-2.78**
P-W3	-3.06	-3.49**	-3.48	-8.49**	-3.45	-11.38**	-3.45	-11.38**	-3.58	-4.21**	-0.68	-5.38**	-0.57	-4.26**	-1.90	-8.76**

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The maximum likelihood procedure for co-integration propounded by Johansen (1988), Johansen and Juselius (1990, 1992) and Juselius (2006) was utilized in this study. This is because the two-step Engle and Granger procedure suffers from the simultaneity problem and the results are sensitive to the choice of dependent variables (Baulch, 1995). Adopting a one-step vector auto-regression method avoids the simultaneity problem and allows hypothesis testing on the co-integration vector, r. The maximum likelihood procedure relies on the relationship between the rank of a matrix and its characteristic roots. The Johansen's maximal eigen value and trace tests detect the number of cointegrating vectors that exist between two or more time series that are econometrically integrated. The results of multiple co-integration test was done using Johansen Maximum Likelihood test to determine the number of co-integrating relations for the fish species (both HVF and LVF) at the wholesale and retail markets (Table 4.27).

Table. 4.27 Results of Johansen co-integration test of fish in the selected districts

No. of CE(s)	Trace test statistics						
	Seerfish	**Pomfret**	**Tuna**	**Sardine**	**Mackerel**	**Anchovies**	**TFB**
None	199.91**	279.55**	320.99**	164.49**	243.20**	172.80**	327.94**
Atmost1	146.58**	202.77**	233.76**	121.29	178.47**	131.54**	208.28**
Atmost2	100.99**	137.11**	170.46**	86.06	128.09**	96.98**	143.62**
Atmost3	62.41	82.64**	119.40**	54.22	84.38**	71.19**	93.02**
Atmost4	43.28	53.84**	78.74**	33.16	47.74	47.23	55.51**
Atmost5	26.29	30.95**	50.18**	19.53	27.82	31.09	34.99**
Atmost6	12.15	13.20	28.91**	8.76	10.65	16.14	20.06**
Atmost7	3.24	2.00	12.82**	3.29	2.68	5.28	8.77**
No of Co-integrating eqn (s)	3	6	8	1	4	4	8

*denotes rejection of the hypothesis at the 0.05 level
** denotes rejection of the hypothesis at the 0.01 level
MacKinnon-Haug-Michelis (1999) p-values

Johansen co-integration test addresses existence of long run relationship among the markets. The results based on trace test likelihood ratio are presented in table. From the result, the likelihood ratio indicated number of co-integrating equations at 5% level of significance as the null hypothesis r = 0 is rejected. The results of multivariate Johansen tests 116 for the fish prices of the selected species at the wholesale and retail market showed that all the species have co-integration relationship. From this it was found that there is existence of relationship in fish prices between wholesale and retail markets.

The trace test indicates the number of co-integrating equation at the 5% significance level. There was one (Sardine), three (Seerfish), four each (mackerel and Anchovies) and eight each (Tuna and Threadfin breams) co-integrating equations between wholesale and retail prices in Ernakulam, Kollam, Idukki and Pathanamthitta districts. Zanoli (1992) reported that where only one co-integrating equation exist, its parameters can be interpreted as estimate of long run co-integrating relationship between variables concerned. Kargbo (2005) stated that the higher the number of co-integrating vectors, the stronger the relationship between the variables in the system. It implies that in this study, market efficiency is enhanced as retail markets respond to price signals from wholesale markets leading to increased returns. Hence, tuna and threadfin bream showed greater long run equilibrium than other fish species studied.

But, Shrimp prices act independently and their prices showed no co-integration relations between markets. It was found that shrimp prices at the selected markets in Kerala were independent of other markets, as the arrivals from aquaculture (cultured system) played a greater role in determining the shrimp price. The shrimp is mainly channelized for international trade due to high demand and unit value realization for the species in international markets. This eliminates the possibility of low of price between the markets and contributed ultimately to inefficient product movements (Baluch, 1997; Adenegen and Bolarinwa, 2010).

The detailed table on vector error correction mechanism (VECM) for the fish species studied is given in Annexure III. The error correction coefficient for seerfish prices was -0.028 in Ernakulam wholesale market and -0.024 in Kollam wholesale market. It measures the speed of adjustment of seerfish prices towards long run equilibrium. It carries the expected negative sign, significant at 5% level and less than one which is appropriate. The co-efficient indicates a feed back of about 2.8% of the previous week's disequilibrium from the long run elasticity i.e deviation of seerfish prices from Ernakulam wholesale market other wholesale markets and retail markets would restored at the rate of 3% i.e within a week among the wholesale and retail markets of seerfish. From the analysis, it is deduced that closer markets are more co-integrated than those that are spatially separated and rate at which disequilibrium is corrected (VECM value) is low for the distant markets.

Ernakulam and Kollam wholesale seerfish markets are independent because current seerfish price not influence by any other wholesale and retail markets. However, Idukki wholesale market current seerfish price was influenced by last week price of own, last week price Kollam whosale market ,last week price Kollam retail market, last week price Idukki retail market. In the case of Pathanamthitta, wholesale market current seerfish price was influenced by last week price of Kollam wholesale market, last week price Idukki wholesale market, last week price, Kollam retail market, last week price Idukki retail market. Ernakulam retail seerfish markets is independent because current seerfish price not influence by any other wholesale and retail markets. Kollam retail market current seerfish price was influenced by last week price of the own market and last week price of Kollam whole sale market. Idukki retail market current seerfish price was influenced by last week price of own and Pathanamthitta retail market current seerfish price was influenced by last week price of own.

The error correction coefficient value for pomfret prices was -0.16 in Idukki district. All other wholesale and retail markets showed non-negative co-efficient values, which showed that these markets are independent. In Idukki, 16 per cent of previous week's retail price of pomfret adjusted within a week time of it's own. In Ernakulam and Kollam, both at wholesale and retail markets pomfret prices are independent and no scope for integration of markets among the markets studied.

The error correction co-efficient for tuna prices was -0.12 in Pathanamthirra market, this implied that 12 per cent of the price disequilibrium will adjust within the market in a week time. The previous week wholesale price of tuna at Ernakulam is influencing the current week retail prices of Idukki. And Kollam retail price of tuna is adjusted by the previous week price of the same market. The speed of adjustment is possible in 8% of week period. From this it was found that the market integration of fish markets for the selected species is possible but slow due to geographical distance between markets. This was explained by Garicia and Salayo (2007) while discussing the issues of low market integration.

The error correction coefficient value for sardine was -2.62 and -2.77 which measured the speed of adjustment of sardine in Kerala. It was found that among the markets studied, the current retail markets at Kollam and Idukki districts are influenced by the previous week wholesale price of sardine at Ernakulam. But, the speed of adjustment is very wider i.e., 262% and 277% of week time of price adjustment. Like wholesale market price of Ernakulam, the previous week retail market price also influenced on Kollam and Idukki retail prices. The speed of adjustment is 71% and 51% in the both markets respectively.

The error correction coefficient value for mackerel was -0.96 i.e., 96% of the current market price of mackerel adjusted on its own within the Idukki market. And the current retail price at Kollam is determined by the previous week wholesale price at Idukki. In the same way, the two week lagged price influenced the current week price at Pathanamthitta wholesale market. The Kollam retail market price was influenced by two weeks and one week lagged prices at wholesale markets of Ernakulam and Kollam respectively.

The error correction coefficient value of anchovies retail prices at Ernakulm and Idukki were influenced by the previous week wholesale prices and the adjustment was possible at 13% and 2.62% in the respective places. Ernakulam one week and two week lagged prices is adjusted in Ernakulam and Idukki retail market prices. Regarding Thread fin bream, the 23% of price adjustment is possible within the market. The kollam and Idukki market prices were influenced by the previous week lagged prices in a greater extent.

Index of market concentration

Index of market concentration (IMC) is the method used for assessing the short run market integration for the selected fish species was carried out. The results of IMC are presented in Table. 4. 28.

The estimated IMC value for the HVF species was 2.93, 1.04 and 0.86 for seerfish, pomfret and tuna respectively. The same for the LVF species was 3.39, 1.18, 1.39 and 0.75 for sardine, mackerel, anchovies and threadfin bream respectively. Only tuna and thread fin bream showed high short run market integration. This showed that price changes in one market will not have any impact on the other market in the same district (Adenegan and Bolarinwa, 2010; Oladapo and Momoh, 2007).

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Table 4.28. Indices of market concentration of wholesale and retail markets in Kerala

Fish species	β_1 Co-efficient	B_3 Co-efficient	IMC	IMC classification	R-square
High Value Fishes					
Seerfish	0.47**	0.16*	2.93	Low SRMI	0.85
Pomfret	0.39**	0.27	1.04	Low SRMI	0.76
Tuna	0.31**	0.21*	0.86	High SRMI	0.91
Low Value Fishes					
Sardine	0.41**	0.12**	3.39	Low SRMI	0.67
Mackerel	0.76**	0.68**	1.18	Low SRMI	0.73
Anchovies	0.53*	0.38	1.39	Low SRMI	0.82
Thread fin bream	0.39*	0.52	0.75	High SRMI	0.89

* SRMI – Short run market integration

It has been highlighted by the previous studies that the price integration of spatially separated markets could be improved by up scaling the infrastructure facilities and enhancing the efficiency in the domestic fish markets (Omar *et al.,* 2015).

4.6. Consumer perception on domestic fish marketing

Consumers are the destination or end point in any of the commodity market. They play a vital role in the supply chain as like fish supply chain. Fish is considered as healthy by consumers than any other animal protein. There is increased awareness of fish consumption among developed countries due to its nutritional and health benefits (Amao *et al.,* 2006). The fish consumption, frequency and consumer preference are largely influenced by geographic, economic, social and cultural factors (Burger *et al.,* 1999; Pieniak *et al.,* 2011; Verbeke & Vackier, 2005). Honkanen *et al.,* 2005 stated that food preferences are affected by sensory (taste, smell, texture) and non-sensory factors (beliefs, behaviour, personal characteristics). There were differences in fish consumption among age groups, gender, education as well as marital status. There is difference in fish consumption between coastal and land locked regions. In the section, the consumer preference in terms of frequency of fish consumption, product form purchased, place of purchase and species preference were studied. In addition to these, the attributes that determine the purchasing behaviour were also analysed.

Fish consumption pattern of consumers in a region gives a picture of demand and supply status of fish. The domestic market for fish in Kerala is governed by the purchasing power of the consumers and also by their tastes and preferences (Shyam *et al.,* 2013). The frequency of fish consumption in the selected districts was studied and it was found that in Ernakulam district 72.22 per cent of households consumed fish daily. In Kollam district also, majority were consuming fish daily (84.44%). In Idukki and Pathanamthitta districts, 51.11 and 56.67 per cent of households consumed fish daily (Fig.4.21). In Idukki district, around 15 per cent household consuming fish once in a month only. This is high among all the districts due to hilly region and preferred to take dried fish than fresh. This shows that fish consumption in the land locked regions are much behind that of coastal regions. Shyam *et al.,* (2013) highlighted that the marine fish consumption is predominant in coastal districts as it is difficult to transport the fishes to land locked and hilly regions with out any quality loss in fish. They added that the demand for fish in land locked regions was met through inland, cultured and freshwater species. It was confirmed that the fish consumption inland locked regions were much behind than coastal regions in Kerala (Needham and Smith, 2014).

Fresh fish is the most preferred form of fish by the people of Kerala. From the study, it was found that 74.56, 83.98, 70.45 and 70.43 per cent of households in Ernakulam, Kollam, Idukki and Pathanamthitta districts preferred to take fish as fresh form (Fig.4.22). Consumers purchase fish either as raw, cleaned, cleaned and cut or raw, cleaned and cut form. In all the four districts selected, majority of consumers like to purchase as cleaned and cut fish rather than raw, because of time saving and convenience in cooking. It was observed that 93.33,61.11, 56.67 and 71.11 per cent of households preferred to purchase fish in a cleaned and cut form in Ernakulam, Kollam, Idukki and Pathanamthitta districts respectively. In Idukki district, one third of consumer purchased as raw and unclean form due to high demand for fresh fish and non-availability of certain fish species during particular season. It was found by Can *et al.*, 2015 that in Turkey also majority of consumers consumed fish as fresh, while in other countries, it is consumed in processed form (FAO, 2013). The reason for not consuming fresh fish was mainly due to high cost, availability and handling inconvenience (Mafimisebi, 2012).

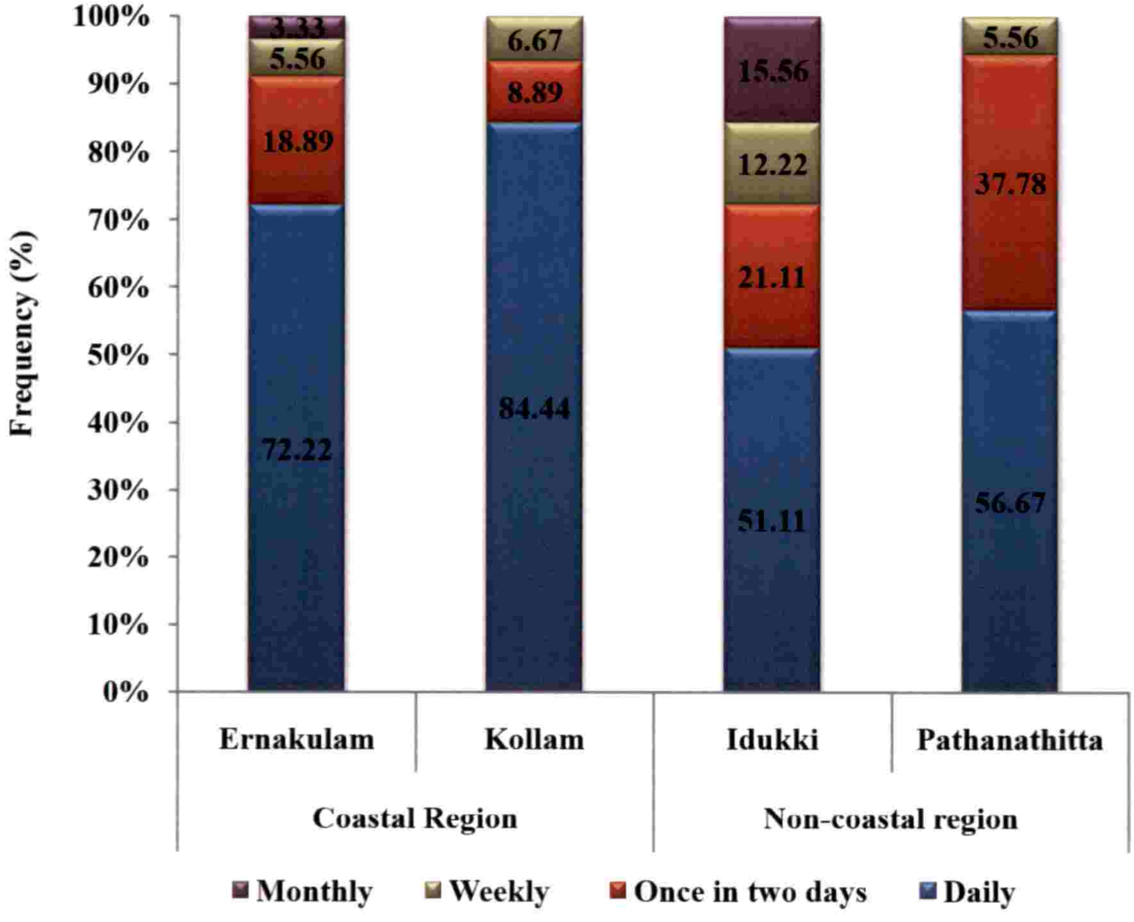

Fig. 4.21 Frequency of fish consumption in the selected districts

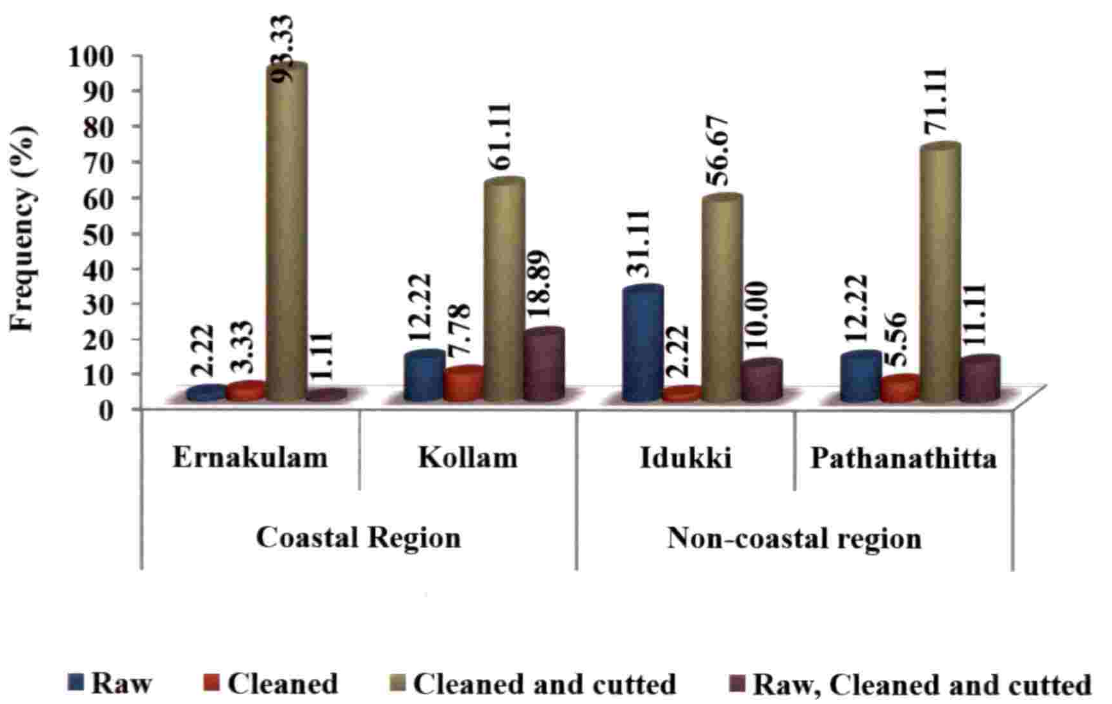

Fig. 4.22 Form of fresh fish purchase in the selected districts

The variation in the form of fish consumption is mainly due to availability of fish in coastal regions. There is a big difference in the quality of fish sold in coastal and land locked districts due to long travel to distant places and lack of mobile cold storage facilities for live transportation of fish. This showed significant paradoxical difference between consumers in coastal and land locked regions in terms of both quantity and quality of fish available to the consumers.

4.5.1 Consumers fish purchasing behavior

Consumers purchase fish from different places based on their convenience. They have preferred to purchase fish of particular species and products. The fish purchase behavior is also determined by certain attributes which has relatively more significant in deciding their purchasing behavior. The aspects of place of fish purchase, species and product preference and the determinants of consumer's perception on fish purchase are discussed in this section.

4.5.1.1 Place of fish purchase

The place of purchase of fish by the consumer varied within and between regions. Generally, the fish is purchased from retail market, super market, door-to-door fisherwomen, vendors on motorcycles, cycles, road side vendors and sometimes from wholesalers and landing centres. In Ernakulam, 48 and 18 per cent of consumers purchase fish from retail and supermarkets respectively. The motorcycle vendors and door-to-door fisherwomen contributed 16 and 11 per cent. The road side vendors (8 %) and wholesale markets (4%) were the least preferred e places of purchase (Fig.4.23). In Kollam, more than 50 per cent of households purchased fish from retail market followed by wholesale markets (17%) (Fig.4.24).

Fish purchased from motorcycle vendors and super markets accounted for 13 per cent each and road side vendors were least preferred (5%). The change in lifestyle has brought change in their place of purchase in super markets which is easy to access and also cleaned and cut form.

In Idukki, there were only two place of fish purchase i.e., 73 per cent consumer purchase from retail market and the rest purchase from wholesalers (Fig.4.25) In Pathanamthitta, consumers purchase mainly from retail market (43%) (Fig.4.26).

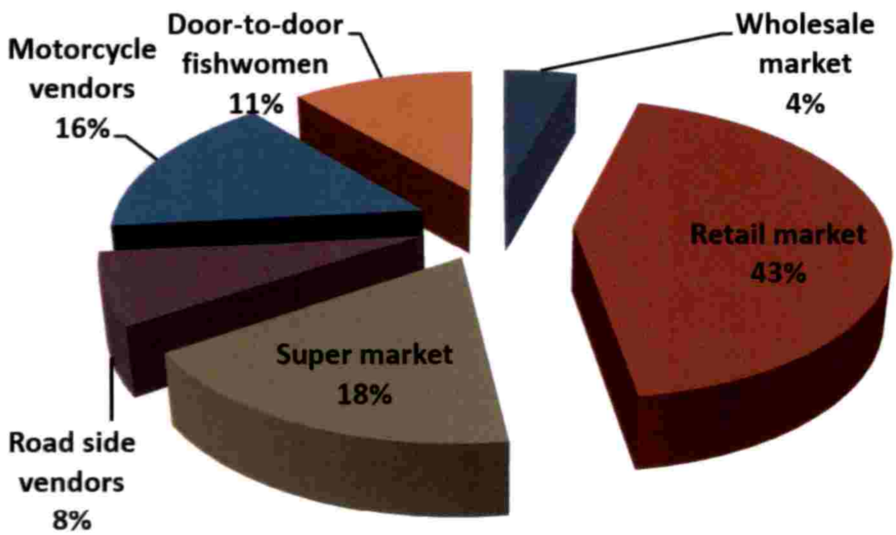

Fig.4.23 Place of fish purchase by the consumers in Ernakulam district

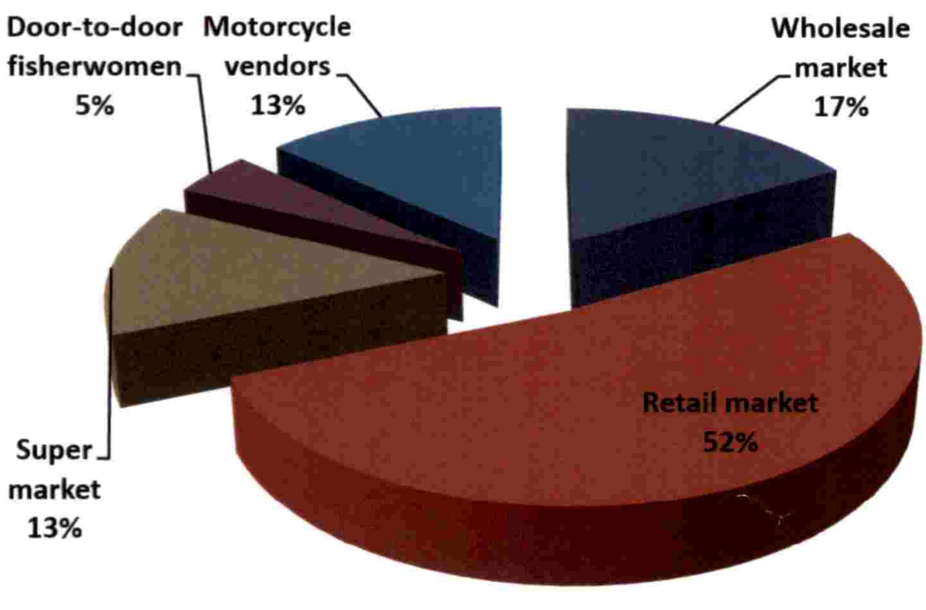

Fig. 4.24 Place of fish purchase by the consumers in Kollam district

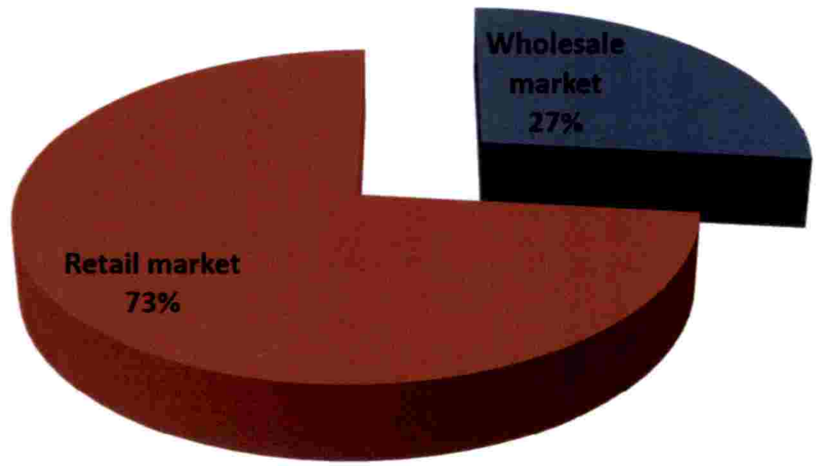

Fig. 4.25 Place of fish purchase by the consumers in Idukki district

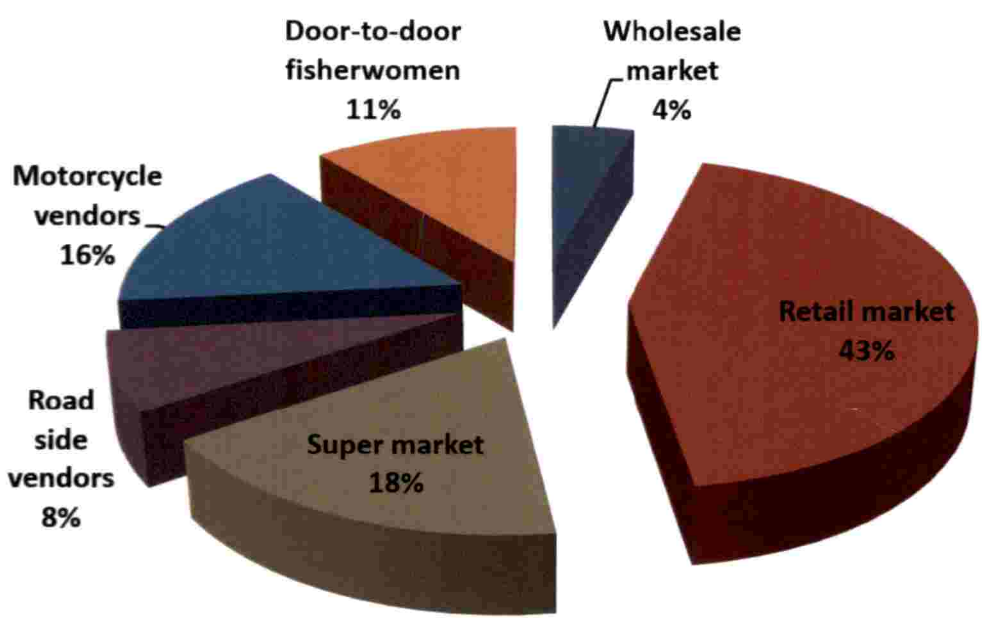

Fig. 4.26 Place of fish purchase by the consumers in Pathanamthitta district

The comparison of coastal (fig. 4.27) and land locked regions (fig.4.28) in terms of place of purchase of fish showed that in both the region, majority of them purchased from retail markets. But, the proportion was high in land locked regions i.e., 73%, while in coastal region it was 48%. This showed that in coastal regions there were plenty of choices to purchase fish which is restricted in land locked regions (Ref). It was revealed that the consumers were not in a position to Super Market concept is a growing industry in India; but sales of seafood so far not a major success, although the potential to grow is high. Current market for seafood is limited due to uncertain in the volume and house hold sector not prepared for such purchase (Nicholas *et al.*, 2015).

4.5.1.2 Species preference

The results showed that sardine is the most preferred species in both coastal and landlocked regions of Kerala with more than 75 and 72 per cent of respondents consuming it daily. Tuna and thread fin bream are generally preferred weekly. Seerfish, pomfret and mackeral are preferred once a month (Fig.4.29). In Kollam, sardine is consumed daily by 76 per cent of consumers. Shrimp and tuna were consumed at least once in a week. Pomfret and mackerel is preferred once a month by 54 and 43 per cent of respondents in Kollam district (Fig.4.30). It was observed from the fig.4.31 and fig 4.32 that in Idukki and Pathanamthitta districts also, sardine was the most preferred species, because of it's taste and high omega-3 fatty acid content which is beneficial for human health. From fig. 4.33, it was revealed that sardine is the most preferred species than any other fish species available in that region. Next to this, pomfret and mackerel were preferred most in the coastal and land locked region respectively (Fig. 4.34).

4.5.1.3 Product preference

Fish is consumed in the fresh, frozen, dried, canned, iced and smoked forms in accordance with the preference or taste of the consumer. Based on the mean value (MV) of preference, the consumers' level of preference for various products were determined. The products of fish such as fresh, frozen, dried, canned, iced and smoked products were ranked by the consumers' based on their preference. The ranks from 5-point scale ranking method were used for this purpose. The product preference of fish in the coastal and land locked districts were presented in tab. In Ernakulam and kollam districts, fresh form is highly preferred with MV of 4.95 and 4.94 respectively.

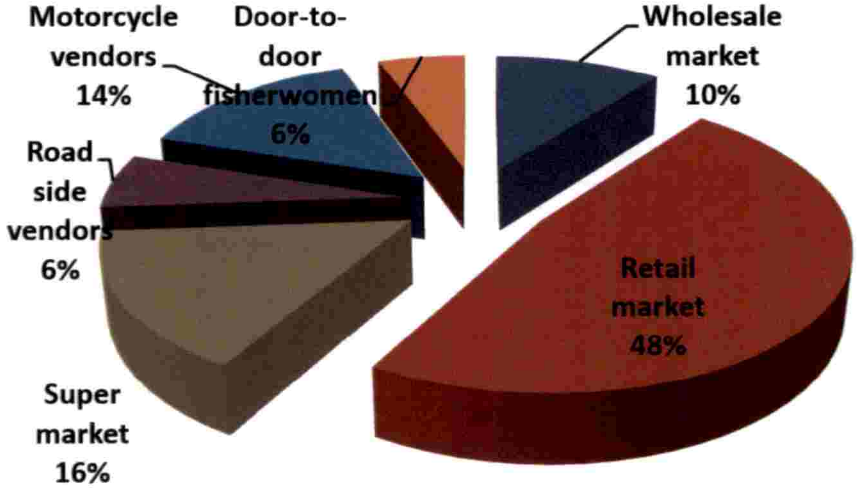

Fig. 4.27 Place of fish purchase by the consumers in Coastal Region

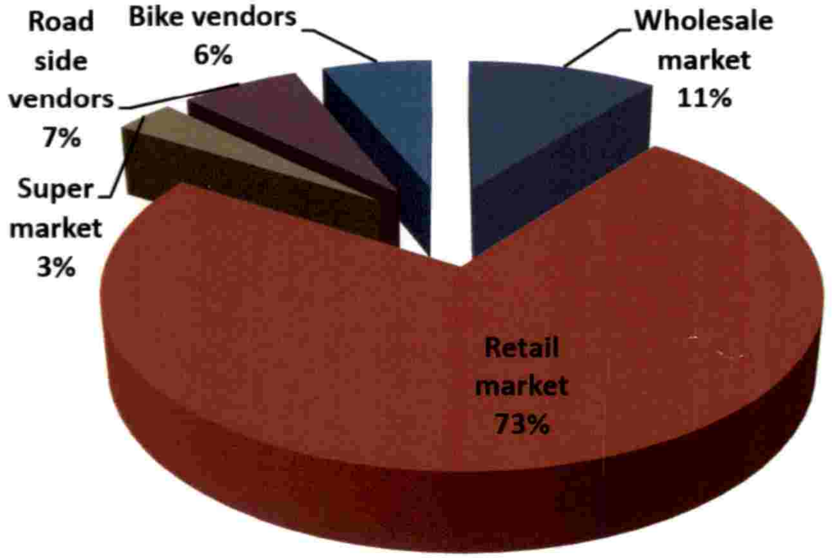

Fig. 4.28 Place of fish purchase by the consumers in land locked Region

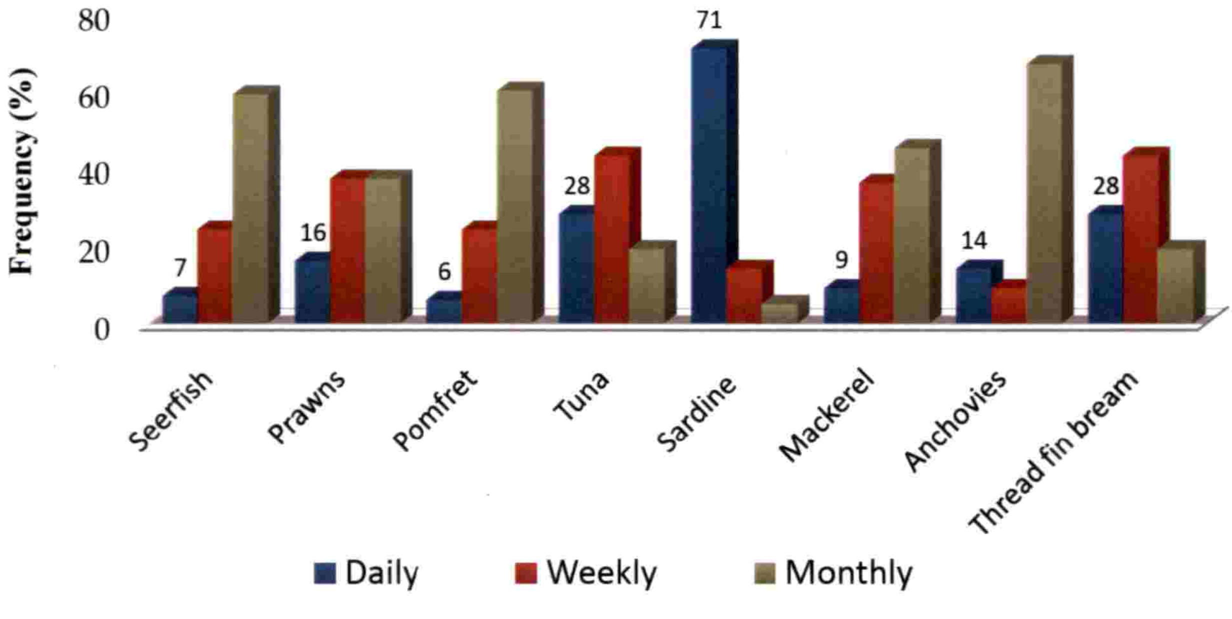

Fig. 4.29 Species preference of respondents in Ernakulam district

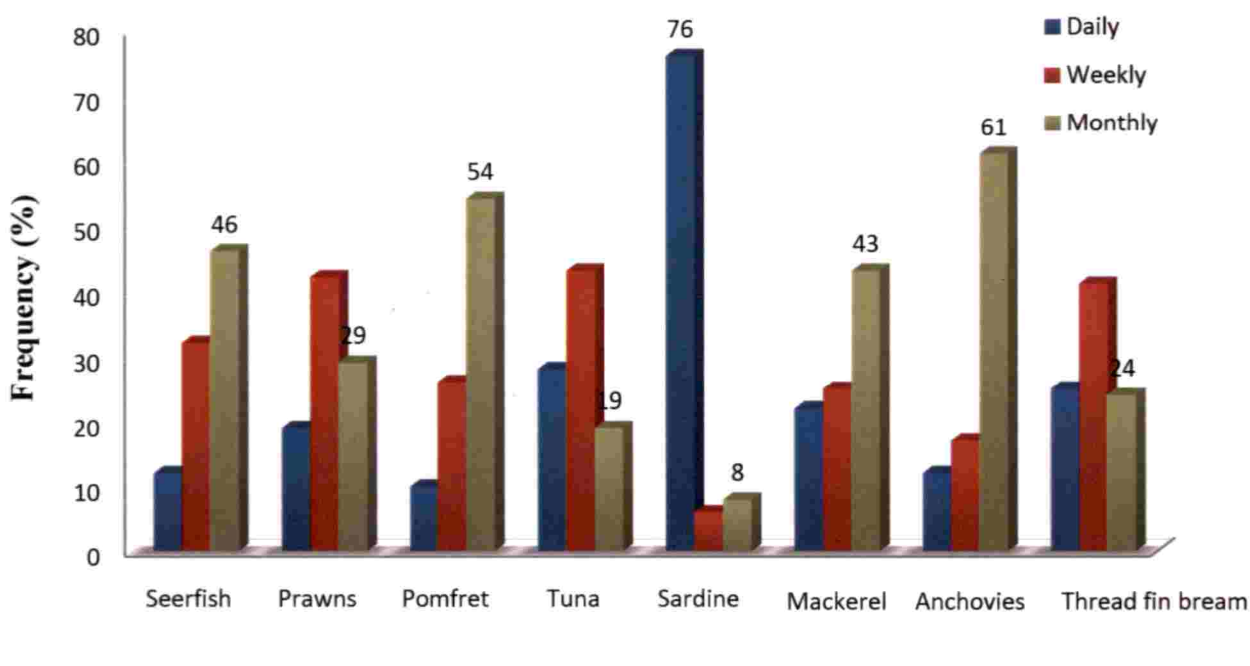

Fig. 4.30 Species preference of respondents in Kollam district

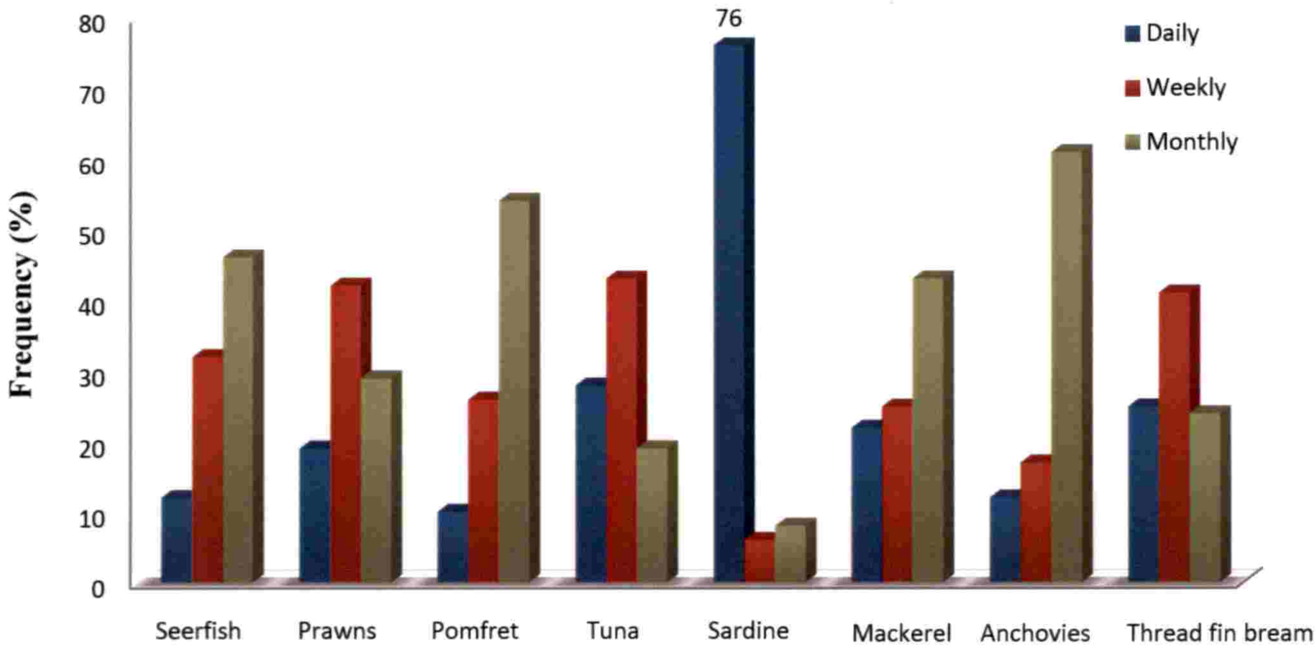

Fig. 4.31 Species preference of respondents in Idukki district

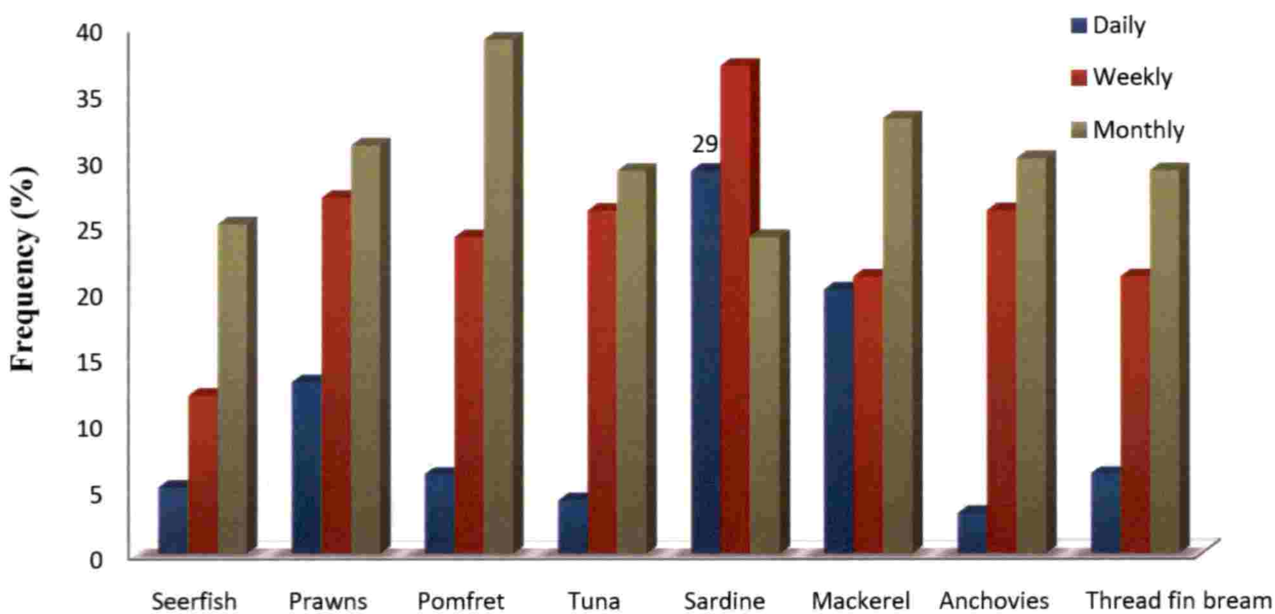

Fig. 4.32 Species preference of respondents Pathanamthitta district

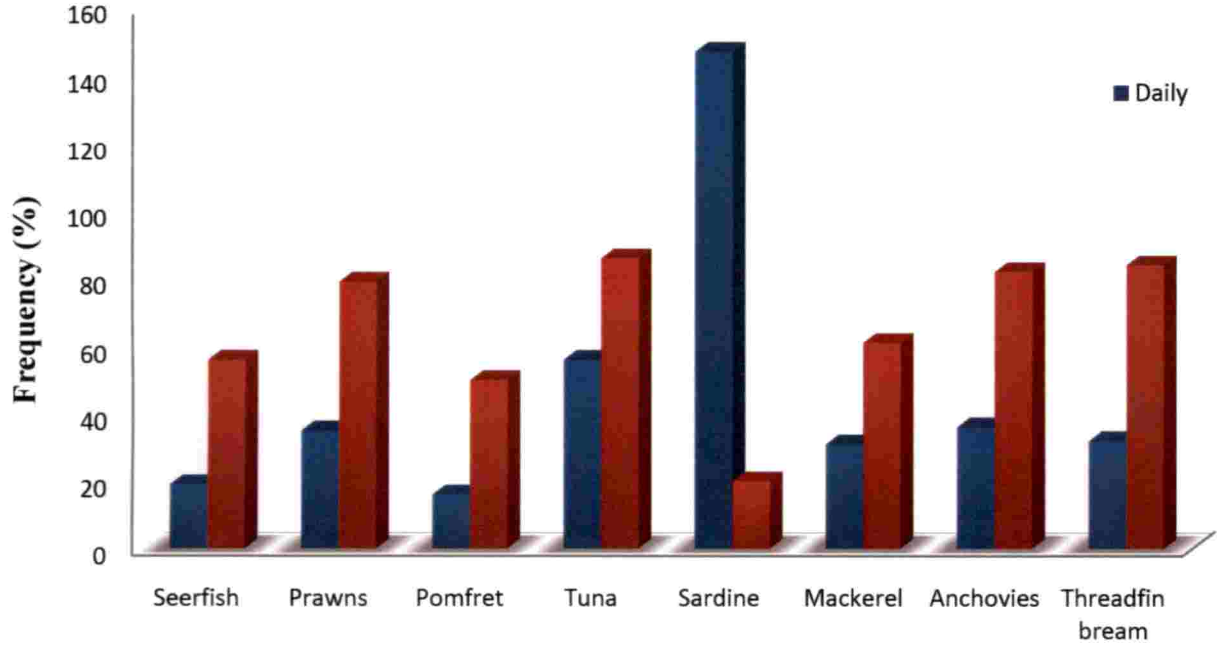

Fig.4.33 Species preference of respondents in Coastal region

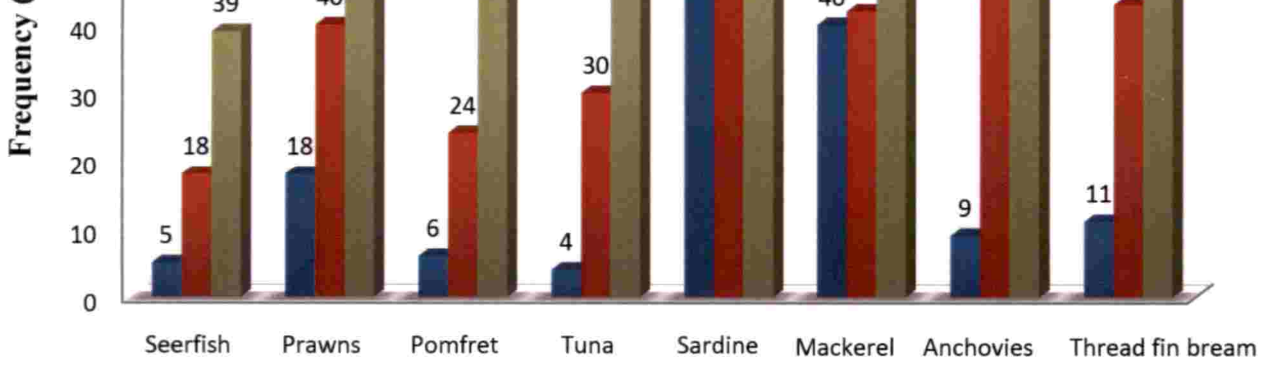

Fig.4.34 Species preference of respondents in land locked region

Dried fish was moderately preferred and each two products were less preferred (frozen and iced) and lest preferred (canned and smoked) in Ernakulam district (Tab. 4.29 & Tab. 4.30).

Table 4.29. Product preference by the respondents at coastal regions

Particulars	Ernakulam			Kollam		
	Mean	Std. Dev	Level of Preference	Mean	Std. Dev	Level of preference
Fresh	4.95	0.26	Highly preferred	4.94	0.34	Highly preferred
Frozen	3.05	1.09	Less preferred	2.45	0.67	Least preferred
Dried	3.68	0.99	Moderately preferred	3.41	0.85	Less preferred
Canned	2.13	1.49	Least preferred	1.3	0.66	Not Preferred
Iced	3.32	1.33	Less preferred	2.34	0.73	Least preferred
Smoked	2.09	1.28	Least Preferred	1.13	0.34	Not Preferred

In Kollam, dried was less preferred (MV:3.41) and frozen and iced were least preferred with the MV of 2.45 and 2.34 respectively. The two products viz., canned and smoked were not at all preferred by the consumers of Kollam district. The reason for fresh fish preference by consumers was attributed by health, safety and family satisfaction (Alapanet *et al.*, 2016). From this study, it was found that the lifestyle changes had not made impact on consumers' preference of fish product (Nicholas *et al.*, 2015).

Table 4.30. Product preference by the respondents at land locked regions

Particulars	Idukki			Pathanamthitta		
	Mean	Std. Dev	Level of preference	Mean	Std. Dev	Level of preference
Fresh	4.70	0.48	Highly preferred	4.96	0.25	Highly preferred
Frozen	3.34	2.28	Less preferred	2.60	0.53	Less preferred
Dried	3.74	1.02	Moderately preferred	3.98	0.83	Moderately preferred
Canned	2.44	1.49	Least preferred	3.22	0.96	Less preferred
Iced	3.05	1.24	Less preferred	2.66	1.14	Less preferred
Smoked	1.45	0.78	Not preferred	1.36	0.48	Not preferred

In Idukki and Pathanamthitta district also, fresh product was preferred a most as like Ernakulam and Kollam districts (Table 4.32). In Idukki, dried was moderately preferred, frozen and iced were less preferred (MV: 3.34 & MV: 3.05), canned was preferred by least (MV: 3.74) and smoked was not at all preferred by the respondents of Idukki district. While, in Pathanamthitta district, dried was preferred moderately (MV: 3.98) and it was frozen, canned and iced that were preferred less (MV: 2.60, MV: 3.22 & MV: 2.66). Smoked products were not preferred by the consumers of Kollam, Idukki and Pathanamthitta.From the results, it was revealed that majority of consumers preferred to purchase fish in fresh form both in coastal and land locked districts. More than 85 per cent of consumers preferred fish in fresh form (FAO, 2008). In line with these results, the similar study was conducted at the cross- country level and stated that in Philippines, fresh form is the most preferred and remaining by canned, smoked or dried. In Nigeria, it was mainly as smoked, fresh and frozen forms (Mafimisebi., 2012).

4.5.2 Determinants of consumer preference for fish

4.5.2.1 Analysis of variance (ANOVA)

The Analysis of Variance (ANOVA) is used to test the significance of the main attributes and the results are presented in Table. 4.31. The determinants of consumer fish consumption was analysed using seven variables of the fish purchase viz., availability, freshness, safety, price, nutrition and package. It is observed for the results revealed the variables which influenced more the consumer behaviour towards fish purchase.

Table 4.31. Determinants of consumer preference for fish

Variables	Ernakulam	Kollam	Idukki	Pathanamthitta
Availability	1.411	1.512	3.271	2.022
Freshness	1.589	1.642	1.271	1.348
Quality	6.144	5.925	5.341	6.236
Safety	3.233	3.975	3.671	3.337
Price	5.444	5.124	5.071	5.079
Nutrition	4.422	4.402	4.435	4.461
Package	5.722	5.520	5.553	5.674
F- value	479.40**	337.15**	100.05**	342.62**

*** Significance at 1% probability level*

From the fish product attributes studied the overall quality, ready availability and taste had the greatest influence on consumer preferences.(Obiero, 2014).This was also influenced by internal consumer behaviour (perception, altitude, and motivation) and external factors (family roles, peer influence and group influence).

4.5.2.2 Conjoint analysis

Conjoint analysis is a multivariate technique mainly used to estimate how consumers develop preferences for certain products which is useful for product development and better consumer satisfaction. Consumption preferences are mainly influenced by socioeconomic characteristics of consumers such as age, education, household size and income. The summary statistics of socio-economic and demographic characteristics of consumers of Ernakulam, Kollam, Idukki and Pathanamthitta districts were tabulated and presented in Table 4.32.

4.5.2.2.1 Demographic variables of the consumers

In each district, 90 respondents were contacted for the study. Totally, 360 consumers were surveyed covering the coastal and land locked regions of the selected districts. The result revealed that majority of respondents were married (CR: 93.14% & LLR: 92.98%) and male (CR: 75.56% & LLR: 85.56%). The average age was 43.16 and 42.58 years in coastal and landlocked regions respectively. And 59.44 and 64.44 per cent of respondents are having household size of 2 to 4. Majority of respondents had school level education. And 71.67% and 52.78% of consumers' monthly income ranged from Rs. 15,000 - 30,000 and below Rs. 15,000 respectively in coastal and landlocked regions.

The respondents of the study belonged to the age group of 36 – 50 in three districts, except Idukki, where they were in the age group of below 35 years. In Ernakulam and Kollam, more than 70 % of male respondents purchased fish from markets. While in land locked districts, more than 80 per cent of males purchased fish from markets i.e., Idukki and Pathanamthitta districts. All the consumers contacted were at least finished schooling except few who completed their post-graduation. Family size determines the quantity of fish purchase. Majority of consumers were with 2 to 4 family members, this shows the predominant of nuclear family (Geethalakshmi *et al.,* 2013). In Ernakulam and Kollam, majority of the consumers belonged to Rs. 15000 – 30000 income level, while in Idukki and Pathanamthitta, they belonged to below Rs. 15,000 income category (Table 4.32).

Table 4.32. Summary statistics for the demographic variables of consumers

Particulars	Coastal Region			Non-coastal region		
	Ernakulam (n=90)	**Kollam (n=90)**	**Total (n=180)**	**Idukki (n=90)**	**Pathanamthitta (n=90)**	**Total (n=180)**
Age (yrs.)						
Below 35	17 (18.89)	43 (47.78)	60 (33.33)	43 (47.78)	27 (30.00)	70 (38.89)
36 to 50	41(45.56)	18 (20.00)	59 (32.78)	39 (43.33)	49 (54.44)	88 (48.89)
Above 50	32 (35.56)	29 (32.22)	61 (33.89)	8 (8.89)	14 (15.56)	22 (12.22)
Gender						
Male	70 (77.78)	66 (73.33)	136 (75.56)	78 (86.67)	76 (84.44)	154 (85.56)
Female	20 (22.22)	24 26.67)	44 (24.44)	12 (13.33)	14 (15.56)	26 (14.44)
Education						
Schooling	55 (61.11)	64 (71.11)	119 (66.11)	56 (62.22)	64 (71.11)	120 (66.67)
Graduate	28 (31.11)	23 (25.56)	51 (28.33)	29 (32.22)	16 (17.78)	45 (25.00)
Post graduate	7 (7.78)	3 (0.33)	10 (5.56)	5 (5.56)	10 (11.11)	15 (8.33)
Family size						
2 to 4	57 (63.33)	50 55.56)	107 (59.44)	55 (61.11)	61 (67.78)	116 (64.44)
5 to 6	25 (27.78)	31 34.44)	56 (31.11)	28 (31.11)	26 (28.89)	54 (30.00)
Above 6	8 (8.89)	9 (10.00)	17 (9.44)	7 (7.78)	3 (3.33)	10 (5.56)
Income level						
Below 15000	13 (14,44)	10 (11.11)	23 (12.78)	42 (46.67)	53 (58.89)	95 (52.78)
15000 – 30000	62 (68.89)	67 (74.44)	129 71.67)	32 (35.56)	20 (22.22)	52 (28.89)
30000 – 50000	10 (11.11)	7 (7.78)	17 (9.44)	15 (16.67)	12 (13.33)	27 (15.00)
Above 50000	5 (5.56)	6 (6.67)	11 (6.11)	1 (1.11)	5 (5.56)	6 (3.33)
Marital status						
Married	76 (84.44)	78 (85.56)	154 91.11)	82 (94.44)	85 (94.44)	167 (92.78)
Unmarried	14 (15.56)	12 (13.33)	26 (14.44)	8 (8.89)	5 (5.56)	13(7.22)

** Figure in parentheses is standard deviation of the variable*

The frequency distribution of responses that consumers preferred as very important and not important was presented in table 4.33. The frequency distribution of responses by the consumers on the attributes selected and their degree of importance were shown in the table.

. Both in Ernakulam and Kollam, consumer considered quality, income, convenience; species and availability are the very important attributes for purchase of fish. In Idukki, the very important attributes were income, availability, quality, appearance and price. While in Pathanamthitta, the consumer considers quality, income, availability and convenience. From this it was found that in coastal regions, quality, income and convenience were important and in land locked regions, quality, income and availability were the important attributes. This method is based on ordering of attributes which does not give the relative importance of attributes (Manalo,1990) and the same has been estimated discussed using conjoint analysis.

Table 4.33. Frequency distribution of consumer responses on attributes

Attributes	Degree of importance											
	Ernakulam			Kollam			Idukki			Pathanamthitta		
	H	M	L	H	M	L	H	M	L	H	M	L
Availability	39	42	19	26	58	16	76	16	8	65	12	23
Choice	15	28	57	25	62	13	12	28	60	15	64	21
Income	71	19	10	85	8	7	85	10	5	75	23	2
Price	24	28	48	14	25	61	34	56	10	38	47	15
Species	62	14	24	65	13	22	23	36	41	32	12	56

** H – High, M - Medium, L – Low*

Fish purchasing behaviour of consumers were defined in the study using five attributes that the consumers looked into while purchase fish. The attributes were availability, choice, income, price and species. Each attribute has two to three levels. The orthogonal design (profiles) of the attributes are generated and presented in table.4.34. The number of combinations was 48. For better consumer evaluation, only eight cards were used excluding three holdout cases.

Table.4.34 Orthagonal design for assessing consumer preference of fish purchasing behavior

S.No.	Card ID	Availability	Choice	Income	Price	Species
1	1	2	1	2	2	2
2	2	1	1	2	3	1
3	3	1	2	2	1	2
4	4	1	2	1	2	1
5	5	2	2	1	3	2
6	6	1	1	1	1	2
7	7	2	2	2	1	1
8	8	2	1	1	1	1
9[a]	9	2	2	2	3	2
10[a]	10	2	1	2	3	1
11[a]	11	2	2	2	1	2

The results of conjoint analysis showed the estimates of the part worth utilities and their relative importance in the selected districts are discussed in this section. Part-worth utility value shows the effect of particular attribute level on consumer preferences of fish. The attribute with highest part-worth is the most preferable alternative by consumers.

Table.4.35 Relative importance of the attributes in the selected districts

Attributes	ERM	KLM	IDI	PTA
Availability	5.14	10.39	28.5	17.21
Choice	17.57	9.32	8.05	6.37
Income	35.84	29.83	23.7	27.3
Price	21.78	27.37	24.6	29.98
Species	19.67	23.09	15.15	19.14
Pearson R	0.81	0.88	0.79	0.80
Kendall tau	0.84	0.90	0.76	0.82

ERM – Ernakulam; KLM – Kollam; IDI – Idukki; PTA - Pathanamthitta

It was found that income, price, species, availability and choice were the major attributes effectively explaining the fish purchasing preferences of consumers in the selected districts. Income expressed highest part-worth utility score in Ernakulam (1.29) and Kollam

(0.89), followed by price. In Idukki, it was availability (0.79) and in Pathanamthitta, price (0.99) expressed highest utility score.

The conformity of the model was evaluated using the Pearson R and Kentall's tau. The Pearson R statistics was 0.81, 0.88, 0.79 and 0.80 and 0.84, 0.90, 0.76 and 0.82 according to Kendall's tau for Ernakulam, Kollam, Idukki and Pathanamthitta respectively. It was found that income is the important factor in Ernakulam and Kollam districts. In Idukki and Pathanamthitta, it was availability and price respectively.

The results summaries the relative importance of attributes in the four districts of Kerala. It was found that income and price were the most important attributes in Ernakulam and Kollam districts. In Idukki, the important attributes were availability followed by price and income. But, in Pathanamthitta, the most important attributes were price and income. In Idukki, price and income were almost equally important in purchasing decisions than other districts. It was found that in Idukki district, availability of fish, nearby to the consumers is not possible due to hilly terrain regions and scattered nature of population in that area. From this it was found that fish purchasing preference is elastic to income and price which is against the results of Shyam, 2014.

Choice is the least important attribute for consumer fish purchase in all the four districts. At many times, purchasers' choice dominates over the family choice while purchasing fish. In land locked regions, supply is low compared to the coastal regions, the supply constraints generally put hindrance on consumers to forgone their choice. It was found that income is one of the strongest factors influencing the consumption and purchase decision of fish (Omu, 1986; Mafimisebi, 2012). Among the four district, irrespective of their coastal or land locked regions, species preference is prominently noticed which showed considerable proportion in all the four districts (above 15% of relative importance). Among the fish species, Sardine is preferred most due to it's taste and nutritional properties (high omega-3 fatty acids). There are instances where some of the low value fishes were discarded onboard or at landing centre due to its size, appearance and low consumer preference (Shyam *et al.,* 2014) which affects the economic value of fish and reduce the market performance considerable.

The internal validity of the model was tested using Pearson R value and Kendall tau statistics. The Pearson correlation co-efficient was 0.81, 0.88, 0.79 and 0.80 in Ernakulam, Kollam, Idukki and Pathanamthitta respectively. The Kendall tau statistics of the same districts were 0.84, 0.90, 0.76 and 0.82 respectively. It is clear from the results that there is strong correlation between the preferences and model estimation. This confirmed that the model has internal validity. Among these, Kollam showed high reliability and least was by Idukki district.

4.6. Constraint analysis of fish market functionaries in the supply chain

The constraints of various market functionaries of fish supply chain i.e., producers, wholesalers, retailers and consumers were listed out for each category. The constraint prioritisation was carried out through focus group discussion with key informants, review of existing relevant literature and personal observations. The Rank Based Quotient (RBQ) technique was used to identify the constraints of market functionaries in the selected districts. The ranks given by producers, wholesalers, retailers and consumers were used for calculating the RBQ value for the constraints identified. Then, the constraints of each functionary were ranked based on the RBQ value estimated for the respective constraints. The high RBQ value implied severity of the problem that needs immediate attention.

4.6.1. Constraint analysis of Producers

The constraints were identified for each market functionaries category through prioritisation. There were nine constraints prioritised by producers, seven by wholesalers, eight each by retailers and consumers. There were 700 respondents conducted for identification of constraints. The calculated RBQ values of the producers at coastal districts of Ernakulam and Kollam were presented in Table 4.36.

Table 4.36. Constraints faced by producers' in the selected coastal districts

Constraints	Ernakulam (n=50)		Kollam (n=50)	
	RBQ value	Rank	RBQ value	Rank
Lack of clean water supply	54.23	6	42.00	6
Lack of cold storage facilities	90.00	1	76.00	2
No price display mechanism	80.43	3	70.50	3
Poor road facilities	30.00	8	10.45	8
Lack of transport facilities	20.15	9	6.79	9
No raised platform for display	60.34	5	57.40	4
Middleman domination	84.17	2	90.05	1
Lack of drainage facilities	70.00	4	44.15	5
Lack of weighing balances	46.00	7	30.65	7

The range of RBQ values varied between 6.79 (lack of transportation) to 90.05 (middleman intervention). From the pooled response of producers in Ernakulam and Kollam districts, the top five constraints of producers' identified were middleman domination, lack of cold storage facilities, absence of price display mechanism, lack of drainage facilities and lack of proper raised platform for display. The similar results were found by Chowdhury (2014) that poor marketing infrastructure facilities, poor road facilities, lack of fast mode of transport, inadequate cold storage and ice supply facilities, unstable fish prices, lack of market information and increasing marketing cost were the constraints in fish marketing.

This result is substantiated by Shyam and Rahman, 2014, while studying the market structure and market intermediaries in Ernakulam, Kozhikode and Alleppey markets. They stated that high marketing costs, lack of infrastructure facilities, price discrimination and high transportation cost were the severe constraints of marketers in different domestic fish markets of Kerala.

4.6.2 Constraint analysis of wholesalers

It was found from the study, that the RBQ value ranged between 33.33 (poor road jnfacilities) to 96.67 (middleman domination) in Ernakulam and in Kollam districts, the RBQ value was ranged between 50.00 (lack of clean water supply) to 100.00 (lack of live fish transportation). The RBQ value was less for lack of clean water supply (33.33) and more for shortage of fish supply (86.67) in Idukki district. The same was observed for Pathanamthitta district with lack of clean water (33.33) at the lower and poor road facilities (82.67) ranked highest (Table 4.37). Salim *et al.,* 2015 mentioned that the fish market constraints as lack of appropriate infrastructure and inadequate amenities.

The pooled RBQ value figured out the first five constraints for the coastal and land locked regions. The first five constraints of wholesalers' in coastal region in the order were lack of live fish transportation, middleman domination, shortage in fish supply, increase in marketing cost and lack of cold storage facilities. Shortage in fish supply, poor road facilities, lack of live fish transportation, middleman domination and lack of cold storage facilities were the top five constraints ranked based on RBQ value in land locked regions (Salim *et al.*, 2015).

4.6.3. Constraints analysis of retailers

The RBQ rank of retailers in coastal and land locked regions for the listed constraints was given in Table 4.38. The RBQ value of retailers ranged between 30 (lack of transportation) to 90 (middleman domination) in Ernakulam district. And the same for Kollam district, it ranged between 40 (lack of clean supply) to 83.33 (lack of cold storage facilities). In Idukki district, less and more RBQ was scored for lack of weighing balances (56.67) and poor road facilities (90.00) respectively, while in Pathanamthtitta district, it was poor road facilities (36.67) and middleman intervention (83.33).

Table 4.37. Constraints faced by Wholesalers' in the selected districts of Kerala

Constraints	Coastal Region				Non-Coastal Region			
	Ernakulam (n=30)		Kollam n=30)		Idukki (n=30)		Pathanamthitta (n=30)	
	RBQ value	Rank	RBQ value	Rank	RBQ value	Rank	RBQ value	Rank
Lack of clean water supply	40.00	6	50.00	7	33.33	7	46.67	7
Lack of cold storage facilities	50.00	5	66.67	5	56.67	6	66.67	4
Poor road facilities	33.33	7	56.67	6	83.33	2	86.67	1
Lack of live fish transportation	86.67	3	100.00	1	76.67	3	80.00	2
Middleman domination	96.67	1	86.67	2	70.00	4	63.33	5
Shortage in fish supply	93.33	2	83.33	3	86.67	1	70.00	3
Increase in marketing cost	66.67	4	76,67	4	60.00	5	56.67	6

Table 4.38. Constraints faced by Retailers' in the selected districts of Kerala

	Coastal Region				Non-Coastal Region			
	Ernakulam (n=30)		Kollam n=30)		Idukki (n=30)		Pathanamthitta (n=30)	
Constraints	**RBQ value**	**Rank**	**RBQ value**	**Rank**	**RBQ value**	**Rank**	**RBQ value**	**Rank**
Lack of clean water supply	50.00	5	40.00	7	70.00	5	40.00	6
Lack of cold storage facilities	80.00	2	83.33	1	83.33	3	63.33	3
Poor road facilities	40.00	6	46.67	6	90.00	1	36.67	8
Lack of live fish transportation	30.00	7	50.00	5	66.67	6	50.00	4
Middleman domination	73.33	3	66.67	3	60.00	7	70.00	2
Shortage in fish supply	90.00	1	80.00	2	76.67	4	83.33	1
Increase in marketing cost	66.67	4	60.00	4	90.00	1	46.67	5

Table 4.39. Constraints faced by consumers' in the selected districts of Kerala

	Coastal Region				Non-Coastal Region			
	Ernakulam (n=30)		Kollam n=30)		Idukki (n=30)		Pathanamthitta (n=30)	
Constraints	**RBQ value**	**Rank**	**RBQ value**	**Rank**	**RBQ value**	**Rank**	**RBQ value**	**Rank**
Increase in fish price	97.78	2	100.00	1	96.67	2	95.56	2
Lack of price transparency	91.11	5	88.88	6	94.44	5	93.33	5
Lack of fish quality and safety	94.44	3	92.22	5	95.56	3	94.44	4
Formaldehyde contamination	100.00	1	98.89	2	97.78	1	96.67	1
Inappropriate handling of fish	92.22	4	95.56	3	94.44	5	95.56	2
No proper icing	88.88	7	93.33	4	93.33	7	91.11	8
Non-availability of fishes species	90.15	6	88.88	6	95.56	3	93.33	5

In most of the fish markets, fishes are sold on the eye-estimation, this is the situation at the landing centres. Weighing machines was rarely used in the fish landing centres and retailers (Ahmed, 1997; Chowdhury, 2004). In some places, these facilities are shared by the group of sellers. It was found from the results that the top five constraints in the pooled response value in coastal regions were middleman domination, lack of cold storage facilities, no raised platform for display, lack of drainage facilities and lack of clean drinking water. In land locked regions, the top constraints were poor road facilities, middleman intervention, lack of cold storage facilities, lack of clean water supply and lack of transportation.

4.6.4. Constraints of consumers

The RBQ rank of in coast consumers and land locked regions for the listed constraints was given in table.4.39. It was found that all the three districts, consumer ranked formaldehyde contamination as the most toughest constraint (Ernakulam: 100, Idukki:97.78 and Pathanamthitta: 96.67). The major constraints of consumers were ranked using RBQ values and it was revealed that formaldehyde contamination, rise in fish price level (Mafimisebi, 2012) inappropriate handling of fish, lack of fish quality and safety were the major problems. The prioritized constraints of the consumers were presence of formaldehyde in fish which needs immediate attention for effective consumer delivery. The issue of antibiotics is prevailed in aquaculture fish than marine fish. But, in recent years, presence of antibiotics, heavy metals and other unwanted substances was indentified and also most common in marine fishes due to water pollution and hazardous chemicals.

4.8. Policy recommendations for improving the marine fish marketing system

Fish supply chain comprises of various stages starting from producer to till reach the consumer. The integrated and co-ordinated effort towards strengthening all the activities and functionaries in the system is necessary towards ensuring sustainable supply chain. The issues associated with the fish marketing can be categorized into two broad lines viz., point of first sale (landing centres/ primary markets) to retail markets of fish and consumers-oriented aspects. In the first category, the issues are mostly of similar in primary markets to retail markets. In this section, the issues relevant to the market performance, integration, consumer perception of fish purchase and the possible policy guidelines were briefly discussed.

- Spatial market integration of selected fish species in Kerala was approached through co-integration and Vector Error Correction Model. The co-integration test showed there is a long run relationship among the wholesale and retail markets considered. From the value of the vector error correction model, indicates that any short term disequilibrium among selected fish prices in the wholesale and retail markets considered will result to a stable long run relationship. It was evident that price movement within fish market in Kerala is efficient. It shows there will be efficient distribution of products according to comparative advantage which is a major source of economic growth. In addition, government can formulate policies of providing infrastructure and information regulatory services to avoid market exploitation, as this will facilitate agricultural development process through price stabilization and production decisions that will boost profit. The study recommends that fisherman should be provided with more price information in order to take advantage of spatial price differences. Also fish market infrastructure that enhances competition among traders should be provided as this minimizes post harvest losses and advantages of spatial price linkages can be achieved.

- The policy implication of this is that when it is desired that a national pricing policy for increased consumption of fresh fish be implemented, the identified leader markets should be the targets. This is because prices formed in them are efficiently transmitted to the other (follower) markets with very minor distortions during the transmission process. If the same policy commences from a follower market as first point of implementation, the effects will be aborted during the transmission stage and the benefits will not reach the target beneficiaries which include the fisher-folk, fish processors, makers of fishing gears and other inputs, market intermediaries, transporters and end-users.

- The high variability in prices calls for an improvement in basic marketing information especially in relation to prices. Weekly or more preferably, daily collection, collation and dissemination of fish price information can be provided by an arm of the Ministry of Agriculture and farmers welfare adequately equipped in terms of finance, facilities and personnel to carry out this function. A wide dissemination of price and market supply information will permit effective arbitraging among markets, reduce uncertainties in market supplies in different locations and considerably reduce the risks associated with inter-market trade. The result of this will be an efficiently functioning network of markets that delivers fish to consumers at an affordable cost with elimination of exploitative tendencies by any group of market intermediaries.

- The results showed that the presences of poor, unhygienic and unorganised structure of fish markets. The presence of infrastructure facilities like weighing balances, assemblage unit, cold storage facilities, ice plants, potable drinking water and drainage facilities are very limited in the marketing system. Hence, the establishment or modernisation of market structures, starting from landing centre would be taken up on priority basis. In this regard, the schemes of National Fisheries Development Board (NFDB) are to be replicated in a large extent towards establishing and upgrading market establishments in a phased manner. The Public-Private Partnership (PPP) mode of initiatives would be a possible hope in establishing market infrastructure development.

- It was observed that the domination middlemen in the fish marketing system are very apparent. Like any other commodity market, fish is highly exploited by middlemen due to it's highly perishable nature. This results in distressed sale or forced sale by the producers and other functionaries. The fish marketing is become most complex due to the presence of relationship dynamics i.e., multiple role by single person (as a middleman, processor, agent and so on). The fish auctioning could be regulated by encouraging fishermen co-operatives in these activities. Co-operative marketing is a better option to strengthen and protect producers' interests. The provision of price display mechanism might be regulated through effective use of ICT tools in fish marketing. The transparency in the system through regional governance mechanism will eliminate the involvement of middleman in the system.

- The handling of fish from 'Catch to consumer' is very common in fish supply chain. The chance of contamination is high in the marketing channel with more actors/ functionaries. In this regard, Compulsory Quality Regulation (CQR) from landing centres to until reach the consumer is to be implemented. The waste disposal in all kinds of fish markets is to be utilised for by-products preparation. As part of 'Swachch Bharat mission' the 'Market cleanliness drive' to be periodically carried out and promoted towards 'Clean Market Environment' programme.

- In general, the market functionaries were not effective in delivering their activities. They are lagging in knowledge and modern technologies towards improving their performance. This end up in inefficient market functions. Hence, towards motivating them to realise and aware of the developments in the system, a fundamental capacity building programme for the actors might be arranged. Other than these, there are certain specific issues in the fish marketing systems. There are,

  i. Bridging the supply gap in the land locked regions through provision of mobile cold chain for effective transport of fish. This is essential to eradicate the nutritional gap among the people of interior areas.

  ii. The system of database on fish arrivals in particular market would be documented to quantify the fish supply and the dynamics in fish landings over the period of time. This is needed for effective policy decisions on fish resource management and for effective fisheries planning and execution.

- From this study, the issue of formaldehyde contamination is mentioned as alarming constraint. Even though, consumers are more nutrition and health conscious, it is beyond their level of understanding. To overcome this, there should be stringent food safety laws and separate cell for regulating the same with enforcement mechanism.

- The problems of low fish supply was reported in both coastal as well as land locked regions, but the latter showed larger extent of supply deficit regions. The consumer preference was more towards fresh fish. Due to change in lifestyle, consumer preference and interest on convenience products were increased. Now-a-days, the cleaned and cut, see-through packed and ready-to-cook fresh fish are in demand among consumers. Hence, the development of convenience products might be an option for supplying fish to land locked regions.

- Consumers are the beneficiaries who create demand in the market. To improve the marketing conditions in better way, the participation of consumers in all kind of market development will be ensured through Customer-Market linkages. Above all, the involvement and co-ordinated and collective effort of market functionaries, consumers, state departments and fisheries co-operatives is the way forward to improve fish marketing system in a holistic and integrated way. The improvement in infrastructure along the supply chain should be developed. Effective distribution and efficient marketing of perishable fish is inevitably essential to ensure remunerative price and enable the fishermen to earn higher income.

Summary and conclusion

5. SUMMARY AND CONCLUSIONS

In India, 85 per cent of fish is consumed as fresh form. But, the distribution of fish through domestic fish markets are failed to address the expectations of the consumers. Majority of the fish markets were unorganised and inefficient for conducting normal marketing functions. Price differences between markets lead to imperfections and market distortions. The market functionaries are facing lot of problems at varying intensity levels. Kerala is one of the major fish producer and consumer, but there were regional difference between coastal and land locked regions within the State. The difference in market infrastructures, performance of market functionaries, integration of markets and consumer preferences on fish purchasing behaviour in the coastal and land locked regions in Kerala were studied.

The major objectives of the study are to identify the supply chain of selected fish species, to assess the structure and performance of domestic fish markets, to examine the market integration and price transmission among the markets, to assess the consumer perception and suggest policy guidelines for improved fish marketing in Kerala. The study confined to Kerala covering two coastal (Ernakulam and Kollam) and two land locked (Idukki and Pathanamthitta) districts. Multi stage stratified random sampling was used for selection of various market functionaries and simple random sampling was followed for selecting the respondents at each stage. In total, 36 sample units consisting of 10 landing centres and 26 fish markets were selected for the study. The required data were collected using pre-tested questionnaire schedule from each market functionaries separately during the period 2015 - 2016. This was discussed detailed in chapter III. The data were analysed using appropriate econometric tools and the results were discussed in chapter IV.

The supply chain of the four high value (seerfish, shrimp, pomfret and tuna) and four low value (sardine, mackerel, anchovies and thread fin bream) fishes were studied. The generic supply chain of the selected fish species was identified and the fish species having additional nodes has been discussed separately. Generally, in domestic marketing system, the fish follows a general pattern of distribution i.e., from producer to wholesalers through auctioneers and to retailers before reaching the consumers. In international marketing, agents and processors/ exporters played a vital role. Most of fishes followed the generic supply chain except sardine, thread fin bream and tuna which were used for feed preparation, surimi and sashmi grade tuna respectively.

The socio-economic profile showed that all the market functionaries are in the age of less than 50 years in both coastal and land locked regions. They were young, active and capable of performing the marketing functions. In coastal regions, functionaries were attained secondary level of education, while in land locked regions, majority of them completed. primary education. The market functionaries in coastal region gained more experience than land locked regions. There family size was between 2-4 numbers of family members.

The profile of domestic fish markets in the both coastal and land locked regions showed that each market has different structure and there are variations based on type of markets, timing, number of consumers visited per day. It was observed that the majority of markets studied were lagging in basic marketing infrastructural facilities for effective market functions. The performance of fish markets was assessed through the performance of producers, wholesalers and retailers using Data Envelopment Analysis (DEA). There were differences in technical efficiency of market functionaries between DMUs, between districts and regions selected for this study. Based on the technical efficiency scores, producers performed well in Ernakulam districts and both wholesalers and retailers well performed in Kollam district. The low performance of DMUs was due to scale inefficiency (units are operated below economies of scale). The technical efficiency was influenced by the average daily revenue (AVR) and Average quantity sales (AQS) by the respective market functionaries. Improving the infrastructure facilities at the markets will improve their performance.

Price transmission and market integration was studied using co-integration analysis. The Augmented Dickey Fuller (ADF) test was used for testing the stationarity of price series of selected fish species. The Johansen Co-integration test showed the number of possible co integration equations derived and the same was estimated for Error Correction Mechanism (ECM) to explore the long run equilibrium. The result explained low degree of long run equilibrium in price series of co-integrated markets. The impact of market concentration index found that markets showed only short run integration.

The consumer perception towards fish purchasing behaviour was analysed from their fish consumption pattern i.e., place of fish purchase, species and product preference. The determinations of consumer preferernce on fish purchase were analysed using conjoint analysis. The attributes viz., species and income were the attributes relatively deciding the consumer preference of fish in Ernakulam, Kollam and Idukki districts, While in Pathanamthitta, it was determined by income and price.

Based on Rank Based Quotient (RBQ), the constraints of the producers, wholesalers, retailers and consumers were ranked and prioritised. The major constraints of market functionaries were middlemen intervention, poor road facilities and lack of infrastructure facilities. Formaldehyde contamination and high fish prices were the constraints expressed by the consumers.

5.1.Conclusions

The study concluded that the supply chain of fish followed a general pattern with addition of nodes in particular fish species was identified.

The technical efficiencies of the market functionaries explained different levels of technical efficiency scores with scale inefficiency in the DMUs. Markets are operated at the below optimum scale of operation due to lack of cold storage facilities and market infrastructures. Fish markets showed low degree of long run integration and low short run integration between spatially separated markets. This ruled out the chance of 'Law of one price' among the markets studied. There is little scope for long run equilibrium in fish prices between market pairs.

Consumer perception was used to analyse the consumer preference towards purchasing fish. Species and income were the major determinants explained well the consumer preferences. Middlemen intervention, lack of market infrastructure and poor road facilities are the major constraints for the market functionaries. The formaldehyde contamination in fish and hike in fish prices are the major constraints of consumers.

It is known that fish is the cheapest protein source which is considered as the potential item of nutrient enriched diet, possible solution for ensuring nutritional security in future. Hence, in Article 11.1 of Code of Conduct for Responsible Fisheries (CCRF) while mentioning the responsible fish utilisation, it was mentioned in the rules that every state should responsible for,

- Encouraging those involved in fish processing, distribution and marketing of fish;
- Adopting appropriate measures to ensure the right of consumers to safe, wholesome and unadulterated fish and fishery products.

To achieve this holistic and integrated management of fish supply chain is vital for over all fisheries development.

5.2. Further line of research

Due to it's significance on nutrition and high demand for fish, the research on efficiency of various supply chains can be taken up for further study. This should cover the aspects of vertical integration and economic modelling of domestic fish markets.

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Appendices

ANNEXURE I

Infrastructure facilities at fish markets in Ernakulam, Kerala

Particulars	Chambakkara	Ernakulam	Thevera
Size	15 cent	10 cent	400 sq. Feet
Year of establishment	200 years old*	More than 200 years *	1976
Number of wholesalers	6	5	3
Number of retailers	400	40	50
Number of consumers	More than 600	400	120-300
Number of labourers	60-70	40	20
Number of loading & unloading labourers	30	6	NA
Type of roof	Concrete	Concrete	Concrete
Single roof or separate units	Separate units	Single roof	Single roof
Type of floor	Cemented / tiles	Cemented	Cemented
Fish displaying platform	No	No	No
Cold storage facilities	Not available	Not available	Not available
Checking quality	Appearance; Smell	Appearance; Smell	Appearance; Smell
Weighing machine	Electronic	Electronic	Electronic
Drainage facilities	imperfect canal	imperfect canal	imperfect canal
Waste Disposal	By corporation, Daily	By corporation, Daily	By corporation, Daily
Price fixing mechanism	Not feasible	Not feasible	Not feasible
Price display system	No	No	No
Toilet facilities	Available	Available	Available

* No written record available.

ANNEXURE II

Supply Chain Analysis of Marine Fish Marketing System in Kerala

Primary Market Survey

Place: **Date:**

Name of the landing centre	:		
Year of establishment	:		
Area of the landing centre (acres)	:		
Size of the landing centre (length and breadth)	:		
Type of Roof	:		
Type of flooring	:	Cemented / Non- cemented	
Platform	:	well developed/not well developed	
Water supply	:	Present/ absent	
If present, type of water source and distance for the source of supply	:		
Electricity supply	:	Present / Not present	
Drainage facilities			
Packing facilities	:		
If package is done, material used for packing	:		
Cold storage facilities	:		
No. of weighing machines	:		
Price display mechanism	:	Available/ not available	
Availability of ice & source	:		
Cost of ice	:		
No. of vehicles transported per day	:		
Transportation charges	:		
Maximum landing & month	:		
Minimum landing & month	:		
No. of fishing vessels landed in a day	:		
Quantity of fish landed (tons.) per day	:		
Revenue generated in the market (Rs./day)	:		
Major species landed	:		
		Male	**Female**
No. of wholesalers	:		
No. of retailers	:		
No. of auctioneers	:		
No. of consumers per day	:		
Distribution channels	:		
Place of distribution	:		

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Landing centre price of fish species	:	

S.No.	Fish Species	Quantity landed (Kg)	Price (Rs. / kg)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Constraints in landing centres			
i.	Lack of clean water supply	:	
ii.	Lack of cold storage facilities	:	
iii.	No price display mechanism at the market	:	
iv.	Poor road communication	:	
v.	Lack of transportation facilities	:	
vi.	No separate assemblage area	:	
vii.	Domination of middle men	:	
viii.	Lack of balance measurement	:	
ix.	No drainage facilities	:	
x.	Lack of preservation facilities	:	

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Supply Chain Analysis of Marine Fish Marketing System in Kerala

Retail Market Survey

Place: **Date:**

Name of the seller	:	
Experience in Marketing (Yrs.)	:	
Marketing of fish as occupation	:	Primary/ Secondary
Any other source of income	:	
Quantity purchased per day	:	
Source of raw material	:	
Distance from landing centre	:	
Distance from wholesale market	:	
Quantity purchased per day	:	
Maximum purchase & month	:	
Minimum purchase & month	:	
No. of consumers visited per day	:	
Working hours per day	:	
Working days per year	:	
Income per day	:	Min: Max:
Monthly income (Rs.)	:	Min: Max:
Number of persons employed in a household	:	
Household income	:	
Type of flooring	:	Cemented / Non- cemented
Type of Roof	:	
Platform	:	well developed/not well developed
Electricity supply	:	Present / Not present
Water supply	:	Present/ absent
If present, type of water source and distance for the source of supply	:	
Drainage facilities	:	
Packing facilities	:	
Material used for packing	:	
Cold storage facilities	:	
No. of weighing machines	:	
Price display mechanism	:	Available/ not available
Availability of ice & source	:	
Cost of ice	:	
Transportation charges	:	
No. of Wholesalers	:	
No. of retailers	:	
No. of auctioneers	:	
No. of vehicles transported per day	:	
No. of consumers per day	:	

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Distribution channels	:	
Place of distribution	:	
No. of fishing vessels landed / day	:	
Total quantity landed per day	:	
Revenue generated in the market (Rs./day)	:	
Retail price of fish species	:	

S.No.	Fish Species	Quantity purchased (Kg)	Price (Rs./kg)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Constraints in marketing			
i.	Lack of clean water supply		
ii.	Lack of cold storage facilities		
iii.	No price display mechanism at the market		
iv.	Poor road communication		
v.	Lack of transportation facilities		
vi.	No separate assemblage area		
vii.	Domination of middle men		
viii.	Lack of balance measurement		
ix.	No drainage facilities		
x.	Lack of preservation facilities		

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Supply Chain Analysis of Marine Fish Marketing System in Kerala

Consumer Survey

Place: **Date:**

Name of the consumer	:					
Location of house	:					
Age (yrs.)	:					
Education	:					
Sex	:	Male/ Female				
Household size	:					
No. of children	:					
Marital status	:	Married/ Unmarried				
Household income (Rs. /Month)	:					
Expenditure on food (Rs. / month)	:					
Expenditure on fish (Rs. / month)	:					
Fish consumption habit	:	Yes / No				
Frequency of fish purchase	:	Daily/ Once in two days/ Weekly/ Monthly/ Others				
Which product you purchase a most?	:	Fresh/ Frozen/ value added/ Ready-to-cook/ Ready-to-eat/ Others				
Form of purchase of fresh fish	:	Raw/ Cleaned/ Cleaned and cutted				
Place of purchase	:	Wholesale market/ Retail market/ Super market/ Road side vendors/ Bike vendors/ doorstep ladies vendors/ others				
Product preference		**Highly preferred**	**Moderately preferred**	**Less preferred**	**Least preferre d**	**Not preferred**
i. Fresh	:					
ii. Frozen	:					
iii. Dried	:					
iv. Canned	:					
v. Iced	:					
vi. Smoked	:					
Which fish species you are likely to purchase	:	**Daily**	**Weekly**		**Monthl y**	**Preference**
i. Seer fish						Most/ least
ii. Pomfret						Most/ least

iii. Prawns						Most/ least
iv. Sardine						Most/ least
v. Mackerel						Most/ least
vi. Anchovies						Most/ least
vii. Threadfin bream						Most/ least
viii. Others						Most/ least
Determinants of purchase	:	Agree	Strongly agree	Disagree	Strongly disagree	Indifferent
Availability						
Freshness						
Quality						
Safety						
Price						
Nutrition						
Packing						
Family Choice						
Purchaser's own choice						
Perceptions	:	(Rank based on opinion)				
Knowledge on quality	:					
Concern on food safety	:					
Trust on brand	:					
Price consciousness	:					
Time of purchase	:					
Convenience	:					
Openness in purchasing new products	:					
Constraints		(Rank accordingly)				
Fish availability (Far distance from markets)	:					
Fish accessibility (Lack of transport)	:					
Fish affordability (High price)	:					
Price fluctuation in a year	:					
Lack of hygiene	:					
Others (if any)	:					

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Supply Chain Analysis of Marine Fish Marketing System in Kerala

Daily Price of selected fish species

Name of the market: **Month:**

(Rs. per kg)

Date		High Value Fish Species			Low value Fish Species			
	Seer Fish	Pomfret	Prawns	Tuna	Sardine	Mackerel	Anchovies	Threadfin bream
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
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30								
31								

ANNEXURE III

Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:54
Sample (adjusted): 4 52
Included observations: 49 after adjustments

Cointegrating Eq:	CointEq1
EWS1AN(-1)	1.000000
KWS1AN(-1)	-0.799933 (0.37812) [-2.11554]
IWS1AN(-1)	0.791710 (0.45869) [1.72602]
PWS1AN(-1)	-1.063374 (0.49394) [-2.15285]
ER1AN(-1)	-0.463483 (0.32125) [-1.44274]
KR1AN(-1)	-0.786598 (0.30343) [-2.59234]
IR1AN(-1)	-0.648561 (0.19021) [-3.40978]
PR1AN(-1)	0.831736 (0.26075) [3.18983]
C	203.1003

Error Correction:	D(EWS1AN)	D(KWS1AN)	D(IWS1AN)	D(PWS1AN)	D(ER1AN)	D(KR1AN)	D(IR1AN)	D(PR1AN)
CointEq1	-0.099001 (0.06862) [-1.44269]	-0.005080 (0.07178) [-0.07077]	0.040770 (0.07712) [0.52865]	-0.005723 (0.07071) [-0.08093]	0.347947 (0.16885) [2.06067]	0.241865 (0.20616) [1.17322]	0.501532 (0.13078) [3.83500]	0.047789 (0.11534) [0.41432]

Vector Error Correction Estimates

D(EWS1AN(-1	-0.06960	0.03610	-0.02606	0.16317	-0.13995	-0.63778	0.02628	0.70613
	(0.16431	(0.17187	(0.18466	(0.16932	(0.40429	(0.49361	(0.31313	(0.27618
	[-0.42360	[0.21006	[-0.14116	[0.96372	[-0.34617	[-1.29208	[0.08393	[2.55682
D(EWS1AN(-2	0.06930	-0.17730	0.01636	0.08755	0.05841	-0.00963	0.42164	0.33811
	(0.16601	(0.17365	(0.18657	(0.17107	(0.40847	(0.49872	(0.31637	(0.27903
	[0.41745	[-1.02104	[0.08774	[0.51181	[0.14300	[-0.01931	[1.33277	[1.21175
D(KWS1AN(-1	-0.07037	0.08351	0.35287	-0.03823	0.45504	0.14588	0.51702	0.15651
	(0.20984	(0.21951	(0.23584	(0.21624	(0.51634	(0.63041	(0.39991	(0.35272
	[-0.33537	[0.38048	[1.49627	[-0.17684	[0.88129	[0.23141	[1.29286	[0.44374
D(KWS1AN(-2	-0.19692	0.03447	-0.16691	0.17732	0.46675	0.22961	0.35108	0.50453
	(0.17175	(0.17966	(0.19303	(0.17699	(0.42261	(0.51598	(0.32732	(0.28869
	[-1.14654	[0.19189	[-0.86470	[1.00192	[1.10445	[0.44501	[1.07261	[1.74765
D(IWS1AN(-1	-0.30839	0.22637	-0.30604	-0.10334	-0.50556	0.35394	-0.69931	0.14178
	(0.18767	(0.19632	(0.21092	(0.19339	(0.46179	(0.56381	(0.35766	(0.31545
	[-1.64325	[1.15309	[-1.45100	[-0.53437	[-1.09480	[0.62777	[-1.95524	[0.44947
D(IWS1AN(-2	-0.25429	-0.02929	-0.27864	0.07722	-0.30572	0.23280	-0.32731	0.09574
	(0.17367	(0.18166	(0.19518	(0.17896	(0.42732	(0.52173	(0.33097	(0.29191
	[-1.46426	[-0.16124	[-1.42764	[0.43152	[-0.71545	[0.44622	[-0.98898	[0.32800
D(PWS1AN(-1	-0.18385	-0.31576	0.00494	-0.10738	0.22115	-0.50035	0.56382	0.23664
	(0.19529	(0.20428	(0.21948	(0.20124	(0.48053	(0.58670	(0.37218	(0.32826
	[-0.94144	[-1.54573	[0.02253	[-0.53359	[0.46022	[-0.85283	[1.51492	[0.72092
D(PWS1AN(-2	0.19841	0.07782	0.04193	-0.16131	-0.12921	0.30767	0.32620	0.20268
	(0.16607	(0.17371	(0.18664	(0.17113	(0.40862	(0.49890	(0.31649	(0.27913
	[1.19478	[0.44800	[0.22471	[-0.94267	[-0.31621	[0.61669	[1.03069	[0.72613
D(ER1AN(-1	-0.04035	0.02087	-0.05482	0.05347	-0.77575	0.03740	0.26890	-0.00366
	(0.06445	(0.06742	(0.07243	(0.06641	(0.15858	(0.19362	(0.12283	(0.10833
	[-0.62619	[0.30966	[-0.75686	[0.80514	[-4.89174	[0.19319	[2.18932	[-0.03383
D(ER1AN(-2	-0.07540	-0.00245	0.03921	0.08443	-0.33910	0.08398	0.11836	0.04996
	(0.06609	(0.06913	(0.07428	(0.06811	(0.16262	(0.19855	(0.12595	(0.11109
	[-1.14097	[-0.03543	[0.52800	[1.23977	[-2.08518	[0.42299	[0.93971	[0.44975
D(KR1AN(-1	-0.08147	0.05725	-0.01187	-0.10316	0.33020	-0.65065	0.17502	0.10239
	(0.06330	(0.06621	(0.07114	(0.06522	(0.15574	(0.19015	(0.12063	(0.10639
	[-1.28724	[0.86478	[-0.16699	[-1.58174	[2.12017	[-3.42177	[1.45096	[0.96244
D(KR1AN(-2	-0.09239	-0.05809	-0.06647	-0.01979	0.16337	-0.34845	0.00780	0.11828
	(0.06048	(0.06327	(0.06798	(0.06233	(0.14883	(0.18170	(0.11527	(0.10166
	[-1.52760	[-0.91817	[-0.97797	[-0.31762	[1.09777	[-1.91769	[0.06772	[1.16354

X

Vector Error Correction Estimates

D(IR1AN(-1))	-0.054710	0.098571	-0.019037	-0.108940	-0.183489	0.063419	-0.509509	-0.155178
	(0.07036)	(0.07360)	(0.07908)	(0.07250)	(0.17313)	(0.21138)	(0.13409)	(0.11827)
	[-0.77757]	[1.33928]	[-0.24075]	[-1.50252]	[-1.05984]	[0.30003]	[-3.79974]	[-1.31212]
D(IR1AN(-2))	-0.036729	0.057269	-0.052379	0.018672	-0.036946	0.131784	-0.494629	-0.059357
	(0.06850)	(0.07165)	(0.07698)	(0.07058)	(0.16854)	(0.20578)	(0.13054)	(0.11513)
	[-0.53622]	[0.79928]	[-0.68042]	[0.26454]	[-0.21921]	[0.64042]	[-3.78915]	[-0.51555]
D(PR1AN(-1))	0.169215	0.132024	-0.009913	0.083698	-0.299894	-0.482047	-0.548428	-0.565865
	(0.10707)	(0.11200)	(0.12033)	(0.11034)	(0.26346)	(0.32167)	(0.20406)	(0.17997)
	[1.58038]	[1.17876]	[-0.08238]	[0.75857]	[-1.13828]	[-1.49858]	[-2.68765]	[-3.14417]
D(PR1AN(-2))	-0.030084	-0.002758	-0.009562	-0.121042	-0.138428	-0.209486	-0.612868	-0.379210
	(0.10945)	(0.11449)	(0.12301)	(0.11279)	(0.26932)	(0.32882)	(0.20859)	(0.18397)
	[-0.27486]	[-0.02409]	[-0.07774]	[-1.07319]	[-0.51400]	[-0.63709]	[-2.93815]	[-2.06124]
C	-0.655379	-0.181457	-0.678108	-0.304184	0.291136	0.006355	-1.766030	-0.141120
	(0.88858)	(0.92949)	(0.99864)	(0.91566)	(2.18643)	(2.66948)	(1.69342)	(1.49357)
	[-0.73756]	[-0.19522]	[-0.67903]	[-0.33220]	[0.13316]	[0.00238]	[-1.04288]	[-0.09448]
R-squared	0.392965	0.296444	0.287305	0.355402	0.647554	0.623252	0.682211	0.483160
Adj. R-squared	0.060075	-0.089377	-0.103528	0.001913	0.454278	0.416649	0.507940	0.199732
Sum sq. resids	1152.127	1260.657	1455.208	1223.420	6975.549	10398.24	4184.433	3255.035
S.E. equation	6.096343	6.377018	6.851437	6.282131	15.00059	18.31467	11.61816	10.24701
F-statistic	1.180465	0.768347	0.735108	1.005412	3.350400	3.016656	3.914654	1.704701
Log likelihood	-146.8878	-149.0934	-152.6095	-148.3588	-191.0075	-200.7885	-178.4870	-172.3334
Akaike AIC	6.730116	6.820139	6.963655	6.790156	8.530917	8.930143	8.019877	7.768709
Schwarz SC	7.425070	7.515093	7.658609	7.485111	9.225871	9.625097	8.714831	8.463663
Mean dependent	-0.204082	-0.408163	-0.408163	-0.204082	0.408163	0.000000	-0.816327	-0.204082
S.D. dependent	6.288149	6.109823	6.522137	6.288149	20.30591	23.97916	16.56260	11.45458

Determinant resid covariance (dof adj.)	7.34E+14
Determinant resid covariance	1.88E+13
Log likelihood	-1305.117
Akaike information criterion	59.47417
Schwarz criterion	65.34267

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:52
Sample (adjusted): 4 52
Included observations: 49 after
adjustments Standard errors in ( ) & t

Cointegrating	CointEq
EWS1MA(-	1.0000
KWS1MA(-	-2.28316 (0.7224 [-3.1602
IWS1MA(-	3.2518 (0.4912 [6.6198
PWS1MA(-	0.9302 (0.6726 [1.3830
ER1MA(-	0.0341 (0.7944 [0.0429
KR1MA(-	-0.30522 (0.8980 [-0.3398
IR1MA(-	-1.40889 (0.2726 [-5.1674
PR1MA(-	-0.19044 (0.2612 [-0.7289
C	6.5427

Error	D(EWS1MA)	D(KWS1MA)	D(IWS1MA)	D(PWS1MA)	D(ER1MA)		D(IR1M	D(PR1M
CointEq	0.0543 (0.0753 [0.7219 -]	0.0547 (0.0399 [1.3710 -]	-0.27573 (0.0676 [-4.0766 -]	-0.11090 (0.0677 [-1.6369 -]	0.0102 (0.0627 [0.1634 -]	0.1334 (0.0981 [1.3603 -]	0.1871 (0.1250 [1.4969 -]	-0.08205 (0.1116 [-0.7347 -]

Vector Error Correction Estimates

D(EWS1MA(-	-0.1153	-0.0583	0.4027	-0.1229	-0.1132	-0.3499	-0.0636	0.2807
	(0.225	(0.119	(0.202	(0.202	(0.187	(0.293	(0.374	(0.334
	[-0.5115	[-0.4883	[1.9896	[-0.6065	[-0.6037	[-1.1919	[-0.1700	[0.8399
D(EWS1MA(-	-0.0018	0.0799	0.3236	0.0453	-0.1552	-0.2826	0.1733	0.3534
	(0.195	(0.103	(0.175	(0.176	(0.163	(0.255	(0.325	(0.290
	[-0.0093	[0.7701	[1.8402	[0.2574	[-0.9521	[-1.1080	[0.5332	[1.2171
D(KWS1MA(-	0.3689	0.0463	-0.5079	-0.3392	0.0230	0.6109	-0.3474	-0.4939
	(0.359	(0.190	(0.322	(0.322	(0.298	(0.467	(0.595	(0.532
	[1.0275	[0.2433	[-1.5758	[-1.0505	[0.0772	[1.3067	[-0.5830	[-0.9280
D(KWS1MA(-	0.1493	0.0165	-0.3322	-0.5342	0.1804	0.8833	0.1720	-0.7876
	(0.344	(0.182	(0.309	(0.310	(0.287	(0.449	(0.572	(0.511
	[0.4330	[0.0905	[-1.0725	[-1.7219	[0.6285	[1.9661	[0.3004	[-1.5400
D(IWS1MA(-	0.0692	-0.2341	0.0405	0.2319	-0.2868	-0.9636	-0.3394	0.0949
	(0.215	(0.114	(0.193	(0.194	(0.179	(0.280	(0.358	(0.319
	[0.3211	[-2.0468	[0.2095	[1.1955	[-1.5975	[-3.4297	[-0.9478	[0.2968
D(IWS1MA(-	0.0596	-0.1310	0.0886	-0.0920	-0.2767	-0.4697	0.0529	0.4587
	(0.205	(0.108	(0.184	(0.184	(0.170	(0.266	(0.340	(0.303
	[0.2907	[-1.2061	[0.4815	[-0.4991	[-1.6217	[-1.7594	[0.1555	[1.5093
D(PWS1MA(-	-0.0837	0.0800	0.1634	-0.4148	-0.0308	0.2648	-0.0778	-0.0983
	(0.149	(0.079	(0.133	(0.134	(0.124	(0.194	(0.247	(0.221
	[-0.5612	[1.0115	[1.2199	[-3.0911	[-0.2483	[1.3631	[-0.3145	[-0.4446
D(PWS1MA(-	0.0170	0.0545	0.0153	-0.5299	0.0224	0.2419	-0.2260	-0.1447
	(0.142	(0.075	(0.128	(0.128	(0.118	(0.185	(0.236	(0.211
	[0.1198	[0.7212	[0.1202	[-4.1300	[0.1889	[1.3019	[-0.9544	[-0.6841
D(ER1MA(-	0.2113	0.1182	-0.2497	-0.0128	-0.3066	0.1225	0.3287	-0.2214
	(0.210	(0.111	(0.189	(0.189	(0.175	(0.274	(0.350	(0.312
	[1.0019	[1.0575	[-1.3188	[-0.0678	[-1.7468	[0.4462	[0.9392	[-0.7080
D(ER1MA(-	-0.0626	0.0721	-0.2503	-0.3201	-0.0353	-0.6090	0.1989	-0.0543
	(0.158	(0.083	(0.141	(0.142	(0.131	(0.205	(0.262	(0.234
	[-0.3965	[0.8607	[-1.7641	[-2.2523	[-0.2689	[-2.9591	[0.7584	[-0.2320
D(KR1MA(-	0.0146	0.0015	0.0960	0.0502	0.5206	-0.4805	-0.0071	0.3853
	(0.128	(0.068	(0.115	(0.115	(0.106	(0.167	(0.213	(0.190
	[0.1140	[0.0231	[0.8335	[0.4349	[4.8724	[-2.8743	[-0.0336	[2.0242
D(KR1MA(-	-0.0300	-0.0017	0.0297	-0.1367	0.2795	-0.0829	0.0319	0.3586
	(0.160	(0.084	(0.143	(0.143	(0.133	(0.208	(0.265	(0.237
	[-0.18783]	[-0.02047]	[0.20667]	[-0.95002]	[2.09809]	[-0.39811]	[0.12023]	[1.51108]

Vector Error Correction Estimates

D(IR1MA(-1))	0.004226	-0.046375	-0.255495	-0.095110	-0.003426	0.330026	-0.040755	0.045672
	(0.10954)	(0.05807)	(0.09835)	(0.09852)	(0.09117)	(0.14265)	(0.18181)	(0.16240)
	[0.03858]	[-0.79860]	[-2.59777]	[-0.96540]	[-0.03758]	[2.31357]	[-0.22417]	[0.28123]
D(IR1MA(-2))	-0.017954	0.076173	-0.180936	-0.144091	-0.010279	-0.049695	-0.234414	0.127844
	(0.10568)	(0.05602)	(0.09489)	(0.09505)	(0.08795)	(0.13762)	(0.17540)	(0.15668)
	[-0.16989]	[1.35967]	[-1.90689]	[-1.51601]	[-0.11687]	[-0.36111]	[-1.33646]	[0.81597]
D(PR1MA(-1))	0.003490	-0.022377	0.004783	-0.126430	0.100048	0.286191	-0.218379	-0.090282
	(0.11610)	(0.06155)	(0.10424)	(0.10442)	(0.09663)	(0.15119)	(0.19270)	(0.17213)
	[0.03006]	[-0.36356]	[0.04588]	[-1.21077]	[1.03540]	[1.89286]	[-1.13326]	[-0.52449]
D(PR1MA(-2))	-0.005327	-0.018347	-0.055827	-0.218021	0.012839	0.258804	-0.028358	-0.172529
	(0.11386)	(0.06036)	(0.10223)	(0.10241)	(0.09476)	(0.14828)	(0.18898)	(0.16881)
	[-0.04679]	[-0.30395]	[-0.54607]	[-2.12897]	[0.13549]	[1.74540]	[-0.15006]	[-1.02202]
C	-0.160359	0.394442	0.464667	0.124836	-0.229298	0.692054	0.099484	0.039217
	(1.07328)	(0.56899)	(0.96369)	(0.96533)	(0.89328)	(1.39772)	(1.78142)	(1.59128)
	[-0.14941]	[0.69323]	[0.48217]	[0.12932]	[-0.25669]	[0.49513]	[0.05585]	[0.02464]
R-squared	0.163664	0.326455	0.516973	0.677830	0.658394	0.594272	0.359990	0.331229
Adj. R-squared	-0.294971	-0.042908	0.252087	0.501155	0.471062	0.371776	0.009017	-0.035516
Sum sq. resids	1672.671	470.1067	1348.532	1353.116	1158.672	2836.785	4608.071	3676.873
S.E. equation	7.345552	3.894192	6.595532	6.606731	6.113633	9.566044	12.19211	10.89077
F-statistic	0.356850	0.883833	1.951683	3.836610	3.514578	2.670932	1.025691	0.903160
Log likelihood	-156.0217	-124.9259	-150.7443	-150.8274	-147.0266	-168.9638	-180.8497	-175.3189
Akaike AIC	7.102928	5.833710	6.887523	6.890916	6.735780	7.631177	8.116315	7.890569
Schwarz SC	7.797882	6.528665	7.582477	7.585870	7.430735	8.326132	8.811270	8.585523
Mean dependent	0.000000	0.204082	0.408163	0.000000	-0.408163	0.408163	0.000000	0.204082
S.D. dependent	6.454972	3.813242	7.626484	9.354143	8.406144	12.06910	12.24745	10.70237

Determinant resid covariance (dof adj.)	1.62E+13
Determinant resid covariance	4.17E+11
Log likelihood	-1211.752
Akaike information criterion	55.66334
Schwarz criterion	61.53184

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:45
Sample (adjusted): 4 52
Included observations: 49 after
adjustments Standard errors in ( ) & t-

Cointegrating	CointEq
EWS1PO(-	1.00000
KWS1PO(-	-0.54378 (0.6147 [-0.8845
IWS1PO(-	-2.78933 (0.4703 [-5.9303
PWS1PO(-	2.70643 (0.6378 [4.2428
ER1PO(-	-1.54658 (0.7142 [-2.1654
KR1PO(-	3.52690 (0.7494 [4.7060
IR1PO(-	3.25654 (0.9390 [3.4677
PR1PO(-	-0.83024 (0.1702 [-4.8774
C	-2707.43

Error	D(EWS1PO)	D(KWS1PO)	D(IWS1PO)	D(PWS1PO)	D(ER1PO)		D(IR1P	D(PR1P
CointEq	0.11267 (0.0508 [2.2150	0.16851 (0.0452 [3.7272	0.25973 (0.0483 [5.3697	0.04510 (0.0587 [0.7672	0.16449 (0.0624 [2.6350	-0.13174 (0.0697 [-1.8890	-0.16189 (0.0669 [-2.4165	0.11647 (0.1172 [0.9937

Vector Error Correction Estimates

D(EWS1PO(-	-0.2167	-0.1674	-0.3599	-0.2014	-0.1354	0.668	-0.0716	0.117
	(0.198	(0.176	(0.188	(0.228	(0.243	(0.271	(0.260	(0.456
	[-1.0937	[-0.9508	[-1.9103	[-0.8799	[-0.5569	[2.4600	[-0.2746	[0.2580
D(EWS1PO(-	-0.2190	0.120	0.037	-0.3615	-0.4620	0.448	-0.2320	-0.3357
	(0.177	(0.158	(0.169	(0.205	(0.218	(0.243	(0.234	(0.409
	[-1.2314	[0.7610	[0.2232	[-1.7588	[-2.1167	[1.8383	[-0.9903	[-0.8191
D(KWS1PO(-	-0.2720	0.095	0.094	0.308	-0.0957	-0.2491	-0.2626	0.369
	(0.208	(0.185	(0.198	(0.240	(0.255	(0.285	(0.274	(0.479
	[-1.3060	[0.5147	[0.4788	[1.2804	[-0.3746	[-0.8724	[-0.9577	[0.7693
D(KWS1PO(-	-0.1202	-0.4249	-0.3111	0.007	-0.3705	0.249	-0.4562	0.185
	(0.201	(0.179	(0.191	(0.232	(0.247	(0.276	(0.265	(0.464
	[-0.5972	[-2.3738	[-1.6247	[0.0332	[-1.4992	[0.9037	[-1.7203	[0.4004
D(IWS1PO(-	0.576	0.167	0.273	-0.1662	0.313	-0.2303	-0.1023	-0.0312
	(0.205	(0.182	(0.195	(0.237	(0.252	(0.282	(0.271	(0.474
	[2.8018	[0.9171	[1.3971	[-0.6988	[1.2422	[-0.8162	[-0.3774	[-0.0659
D(IWS1PO(-	0.166	0.216	0.299	0.239	0.220	-0.2490	0.195	0.314
	(0.195	(0.173	(0.185	(0.225	(0.239	(0.267	(0.257	(0.450
	[0.8529	[1.2491	[1.6138	[1.0626	[0.9182	[-0.9297	[0.7612	[0.6985
D(PWS1PO(-	0.001	-0.0367	-0.0669	-0.4245	-0.5089	0.470	0.491	-0.4356
	(0.146	(0.130	(0.139	(0.169	(0.179	(0.200	(0.192	(0.337
	[0.0100	[-0.2826	[-0.4807	[-2.5091	[-2.8326	[2.3457	[2.5482	[-1.2913
D(PWS1PO(-	-0.1445	-0.4290	-0.3302	-0.3813	-0.1091	0.547	0.110	0.195
	(0.148	(0.132	(0.141	(0.172	(0.182	(0.204	(0.196	(0.342
	[-0.9710	[-3.2433	[-2.3333	[-2.2168	[-0.5973	[2.6819	[0.5637	[0.5690
D(ER1PO(-	-0.0879	0.009	0.109	-0.1702	-0.4176	-0.2893	-0.2304	0.106
	(0.103	(0.091	(0.097	(0.119	(0.126	(0.141	(0.135	(0.237
	[-0.8531	[0.1016	[1.1136	[-1.4301	[-3.3035	[-2.0481	[-1.6982	[0.4505
D(ER1PO(-	0.094	0.149	0.200	0.140	-0.2555	-0.3154	-0.0495	-0.1063
	(0.104	(0.093	(0.099	(0.121	(0.128	(0.143	(0.138	(0.241
	[0.8987	[1.6085	[2.0097	[1.1614	[-1.9859	[-2.1937	[-0.3589	[-0.4402
D(KR1PO(-	-0.3555	-0.3790	-0.6021	-0.1638	-0.5510	-0.4006	0.580	0.078
	(0.173	(0.154	(0.165	(0.200	(0.213	(0.238	(0.228	(0.400
	[-2.0482	[-2.4567	[-3.6476	[-0.8167	[-2.5865	[-1.6831	[2.5407	[0.1960
D(KR1PO(-	-0.2733	-0.3259	-0.4600	-0.2148	-0.0155	-0.0986	0.334	-0.1811
	(0.149	(0.132	(0.142	(0.172	(0.183	(0.204	(0.196	(0.344
	[-1.82959]	[-2.45423]	[-3.23773]	[-1.24410]	[-0.08496]	[-0.48151]	[1.70132]	[-0.52619]

Vector Error Correction Estimates

D(IR1PO(-1))	-0.258840 (0.14059) [-1.84105]	-0.049396 (0.12496) [-0.39530]	-0.431593 (0.13369) [-3.22837]	0.081006 (0.16248) [0.49856]	-0.699444 (0.17253) [-4.05395]	-0.003146 (0.19276) [-0.01632]	-0.994828 (0.18516) [-5.37281]	-0.283719 (0.32396) [-0.87579]
D(IR1PO(-2))	-0.118879 (0.10301) [-1.15406]	-0.045781 (0.09155) [-0.50006]	-0.270762 (0.09795) [-2.76428]	0.092634 (0.11905) [0.77813]	-0.368980 (0.12641) [-2.91887]	-0.208424 (0.14123) [-1.47579]	-0.530958 (0.13566) [-3.91382]	0.083232 (0.23736) [0.35066]
D(PR1PO(-1))	0.107522 (0.08801) [1.22177]	0.243360 (0.07822) [3.11134]	0.236474 (0.08368) [2.82584]	0.269971 (0.10171) [2.65441]	0.213511 (0.10800) [1.97697]	-0.324606 (0.12066) [-2.69030]	-0.075656 (0.11590) [-0.65276]	-0.457339 (0.20278) [-2.25531]
D(PR1PO(-2))	0.078728 (0.07798) [1.00960]	0.061993 (0.06931) [0.89448]	0.086258 (0.07415) [1.16330]	0.187989 (0.09012) [2.08597]	0.076316 (0.09570) [0.79748]	-0.206772 (0.10691) [-1.93403]	-0.015292 (0.10270) [-0.14891]	0.103085 (0.17968) [0.57371]
C	0.158617 (2.21719) [0.07154]	-1.058120 (1.97058) [-0.53696]	-1.380611 (2.10829) [-0.65485]	0.030768 (2.56238) [0.01201]	-0.277946 (2.72090) [-0.10215]	1.097045 (3.03983) [0.36089]	0.191210 (2.92001) [0.06548]	3.029474 (5.10888) [0.59298]
R-squared	0.340825	0.654339	0.663638	0.475027	0.772339	0.691815	0.878563	0.584963
Adj. R-squared	-0.020658	0.464783	0.479182	0.187139	0.647492	0.522811	0.811968	0.357362
Sum sq. resids	7172.901	5666.023	6485.601	9580.221	10802.29	13483.07	12441.11	38083.87
S.E. equation	15.21131	13.51943	14.46419	17.57952	18.66711	20.85516	20.03313	35.05014
F-statistic	0.942852	3.451952	3.597807	1.650039	6.186312	4.093476	13.19271	2.570127
Log likelihood	-191.6910	-185.9133	-189.2232	-198.7811	-201.7225	-207.1536	-205.1831	-232.5933
Akaike AIC	8.558816	8.322993	8.458090	8.848207	8.968264	9.189941	9.109512	10.22830
Schwarz SC	9.253770	9.017948	9.153045	9.543161	9.663218	9.884895	9.804467	10.92325
Mean dependent	0.612245	-0.408163	-0.612245	1.020408	1.020408	0.000000	1.020408	1.530612
S.D. dependent	15.05658	18.47963	20.04247	19.49839	31.44074	30.19037	46.19907	43.72266

Determinant resid covariance (dof adj.)	7.38E+19
Determinant resid covariance	1.89E+18
Log likelihood	-1587.303
Akaike information criterion	70.99198
Schwarz criterion	76.86048

Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:50
Sample (adjusted): 4 52
Included observations: 49 after

Cointegrating	CointEq
EWS1SA(-	1.00000
KWS1SA(-	-0.14827 (0.0784 [-1.8899
IWS1SA(-	-0.37277 (0.1323 [-2.8175
PWS1SA(-	-0.11477 (0.0589 [-1.9470
ER1SA(-	0.27414 (0.0299 [9.1549
KR1SA(-	-0.26797 (0.0273 [-9.7837
IR1SA(-	-0.34319 (0.0271 [-12.621
PR1SA(-	-0.11441 (0.0190 [-6.0039
C	40.4172

Error	D(EWS1SA)	D(KWS1SA)	D(IWS1SA)	D(PWS1SA)		D(KR1S	D(IR1S	D(PR1S
CointEq	-0.38984 (0.3295 [-1.1830	-0.44695 (0.3309 [-1.3504	-0.36011 (0.2538 [-1.4185	0.66895 (0.2421 [2.7631	-0.99747 (0.8575 [-1.1631	3.12796 (0.9455 [3.3082	3.43693 (0.9320 [3.6873	0.70917 (0.8721 [0.8131

Vector Error Correction Estimates

D(EWS1SA(-	-0.2884 (0.396 [-0.7275	-0.4570 (0.398 [-1.1477	0.637 (0.305 [2.0879	-0.7396 (0.291 [-2.5392	0.357 (1.031 [0.3466	-2.6161 (1.137 [-2.2997	-2.7748 (1.121 [-2.4744	-1.1234 (1.049 [-1.0706
D(EWS1SA(-	0.310 (0.405 [0.7656	0.581 (0.407 [1.4278	1.067 (0.312 [3.4190	-0.3350 (0.297 [-1.1249	0.121 (1.054 [0.1155	-2.3884 (1.163 [-2.0536	-1.8267 (1.146 [-1.5932	-0.8057 (1.072 [-0.7510
D(KWS1SA(-	0.049 (0.337 [0.1455	0.160 (0.338 [0.4747	0.155 (0.259 [0.5987	0.359 (0.247 [1.4519	-0.0966 (0.877 [-0.1101	0.690 (0.967 [0.7134	0.462 (0.953 [0.4849	0.157 (0.892 [0.1759
D(KWS1SA(-	-0.4529 (0.317 [-1.4272	-0.6071 (0.318 [-1.9047	-0.5447 (0.244 [-2.2280	0.323 (0.233 [1.3885	0.583 (0.825 [0.7063	1.592 (0.910 [1.7481	1.090 (0.897 [1.2150	0.402 (0.840 [0.4795
D(IWS1SA(-	-0.2447 (0.215 [-1.1381	-0.3413 (0.216 [-1.5802	-0.9298 (0.165 [-5.6120	0.120 (0.158 [0.7649	0.045 (0.559 [0.0817	0.707 (0.617 [1.1465	0.779 (0.608 [1.2809	0.096 (0.569 [0.1692
D(IWS1SA(-	-0.1690 (0.187 [-0.9004	-0.3297 (0.188 [-1.7484	-0.3643 (0.144 [-2.5184	0.267 (0.137 [1.9425	0.309 (0.488 [0.6338	-0.2395 (0.538 [-0.4446	0.428 (0.531 [0.8067	-0.2489 (0.496 [-0.5009
D(PWS1SA(-	0.633 (0.278 [2.2784	0.566 (0.279 [2.0258	0.307 (0.214 [1.4364	-0.1219 (0.204 [-0.5968	-0.7548 (0.723 [-1.0426	0.785 (0.798 [0.9841	-0.4900 (0.786 [-0.6227	-0.3235 (0.736 [-0.4394
D(PWS1SA(-	-0.0965 (0.288 [-0.3342	0.123 (0.290 [0.4258	-0.3386 (0.222 [-1.5215	-0.2928 (0.212 [-1.3798	-0.5262 (0.751 [-0.6999	0.325 (0.828 [0.3931	0.657 (0.817 [0.8044	-0.7989 (0.764 [-1.0449
D(ER1SA(-	0.102 (0.085 [1.1967	0.093 (0.085 [1.0866	0.212 (0.065 [3.2214	-0.1150 (0.062 [-1.8300	-0.2341 (0.222 [-1.0510	-0.7172 (0.245 [-2.9198	-0.5105 (0.242 [-2.1085	-0.0091 (0.226 [-0.0405
D(ER1SA(-	0.056 (0.072 [0.7768	0.056 (0.073 [0.7645	0.002 (0.056 [0.0391	-0.0197 (0.053 [-0.3688	0.093 (0.189 [0.4905	-0.1238 (0.209 [-0.5917	-0.0945 (0.206 [-0.4583	-0.0479 (0.193 [-0.2486
D(KR1SA(-	-0.1554 (0.097 [-1.5919	-0.0875 (0.098 [-0.8928	-0.2258 (0.075 [-3.0013	-0.0078 (0.071 [-0.1089	0.095 (0.254 [0.3744	-0.0068 (0.280 [-0.0245	0.892 (0.276 [3.2312	0.379 (0.258 [1.4670
D(KR1SA(-	-0.1058 (0.103 [-1.0181 9]	-0.1980 (0.104 [-1.8975 1]	-0.0662 (0.080 [-0.8277 2]	0.065 (0.076 [0.8614 8]	-0.0598 (0.270 [-0.2214 8]	0.235 (0.298 [0.7912 6]	0.106 (0.293 [0.3617 0]	0.135 (0.275 [0.4938 5]

Vector Error Correction Estimates

D(IR1SA(-1))	-0.079009	-0.035880	-0.270165	0.114130	-0.037190	0.777251	0.734097	-0.011984
	(0.09199)	(0.09239)	(0.07087)	(0.06758)	(0.23938)	(0.26394)	(0.26019)	(0.24347)
	[-0.85892]	[-0.38835]	[-3.81228]	[1.68875]	[-0.15536]	[2.94477]	[2.82135]	[-0.04922]
D(IR1SA(-2))	-0.001661	-0.040403	-0.095708	0.138375	-0.175822	0.359981	0.494232	0.235650
	(0.08374)	(0.08411)	(0.06452)	(0.06153)	(0.21793)	(0.24029)	(0.23688)	(0.22165)
	[-0.01984]	[-0.48035]	[-1.48346]	[2.24904]	[-0.80679]	[1.49811]	[2.08646]	[1.06317]
D(PR1SA(-1))	-0.041642	-0.040923	-0.020681	0.130484	0.109661	0.107309	0.502029	-0.084153
	(0.07773)	(0.07807)	(0.05988)	(0.05711)	(0.20228)	(0.22303)	(0.21986)	(0.20573)
	[-0.53574]	[-0.52419]	[-0.34536]	[2.28490]	[0.54214]	[0.48114]	[2.28338]	[-0.40905]
D(PR1SA(-2))	-0.014538	-0.131764	-0.014240	0.086187	0.253597	0.028832	0.493039	0.024984
	(0.07006)	(0.07037)	(0.05397)	(0.05147)	(0.18232)	(0.20103)	(0.19817)	(0.18543)
	[-0.20750]	[-1.87252]	[-0.26383]	[1.67442]	[1.39096]	[0.14343]	[2.48796]	[0.13473]
C	0.213746	0.082790	0.266144	-0.312267	0.134438	-0.816399	-0.295148	-1.079425
	(0.68476)	(0.68777)	(0.52754)	(0.50309)	(1.78197)	(1.96482)	(1.93691)	(1.81240)
	[0.31215]	[0.12038]	[0.50450]	[-0.62069]	[0.07544]	[-0.41551]	[-0.15238]	[-0.59558]
R-squared	0.651140	0.684147	0.685517	0.607776	0.508869	0.488240	0.512198	0.347197
Adj. R-squared	0.459830	0.510937	0.513059	0.392685	0.239539	0.207597	0.244694	-0.010792
Sum sq. resids	688.8207	694.8764	408.8279	371.8124	4664.745	5671.141	5511.168	4825.415
S.E. equation	4.713812	4.734487	3.631528	3.463228	12.26685	13.52553	13.33340	12.47632
F-statistic	3.403578	3.949821	3.974970	2.825674	1.889387	1.739719	1.914727	0.969853
Log likelihood	-134.2854	-134.4999	-121.5041	-119.1789	-181.1492	-185.9355	-185.2344	-181.9789
Akaike AIC	6.215732	6.224485	5.694045	5.599140	8.128539	8.323896	8.295283	8.162403
Schwarz SC	6.910686	6.919439	6.388999	6.294094	8.823493	9.018851	8.990237	8.857357
Mean dependent	0.102041	0.000000	0.000000	-0.204082	0.204082	-0.612245	0.204082	-0.408163
S.D. dependent	6.413673	6.770032	5.204165	4.444002	14.06677	15.19432	15.34191	12.40954

Determinant resid covariance (dof adj.)	1.58E+12
Determinant resid covariance	4.06E+10
Log likelihood	-1154.670
Akaike information criterion	53.33349
Schwarz criterion	59.20199

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:47
Sample (adjusted): 4 52
Included observations: 49 after
adjustments Standard errors in ( ) & t

Cointegrating	CointEq
EWS1SE(-	1.00000
KWS1SE(-	0.05053 (0.0484 [1.0424
IWS1SE(-	72.7799 (0.1405 [517.97
PWS1SE(-	-72.7744 (0.1321 [-550.74
ER1SE(-	-0.17303 (0.0327 [-5.2803
KR1SE(-	-0.15603 (0.0436 [-3.5762
IR1SE(-	-0.02550 (0.0256 [-0.9934
PR1SE(-	0.02877 (0.0277 [1.0364
C	-208.013

Error	D(EWS1SE)	D(KWS1SE)	D(IWS1SE)	D(PWS1SE)		D(KR1S	D(IR1S	D(PR1S
CointEq	-0.02817 (0.0043 [-6.5369	-0.02365 (0.0097 [-2.4386	-0.01144 (0.0090 [-1.2621	0.00897 (0.0090 [0.9882	-0.00511 (0.0135 [-0.3775	0.01910 (0.0140 [1.3564	0.00679 (0.0193 [0.3517	-0.01765 (0.0134 [-1.3159

Vector Error Correction Estimates

D(EWS1SE(-1	-0.2124 (0.158 [-1.3373	0.111 (0.357 [0.3114	-0.3496 (0.334 [-1.0467	-0.3592 (0.334 [-1.0732	0.967 (0.499 [1.9360	0.134 (0.518 [0.2600	-0.2469 (0.711 [-0.3469	-0.2839 (0.494 [-0.5743
D(EWS1SE(-2	-0.0511 (0.154 [-0.3309	-0.2878 (0.347 [-0.8284	0.209 (0.324 [0.6441	0.200 (0.325 [0.6175	0.558 (0.485 [1.1490	-0.5640 (0.504 [-1.1182	-0.1757 (0.691 [-0.2540	-0.9543 (0.480 [-1.9862
D(KWS1SE(-1	0.106 (0.076 [1.4042	0.158 (0.171 [0.9269	1.024 (0.160 [6.4038	1.025 (0.160 [6.3949	0.059 (0.239 [0.2473	-0.5368 (0.248 [-2.1596	-0.4392 (0.340 [-1.2883	-0.2092 (0.236 [-0.8836
D(KWS1SE(-2	-0.1806 (0.123 [-1.4675	-0.2939 (0.277 [-1.0611	-0.3420 (0.258 [-1.3213	-0.3409 (0.259 [-1.3148	-0.1020 (0.387 [-0.2635	0.281 (0.402 [0.7001	0.731 (0.551 [1.3259	0.667 (0.383 [1.7413
D(IWS1SE(-	0.356 (0.316 [1.1264	0.139 (0.713 [0.1960	-1.2017 (0.666 [-1.8035	-1.3593 (0.667 [-2.0362	-0.7622 (0.996 [-0.7646	0.470 (1.035 [0.4541	0.044 (1.419 [0.0316	1.556 (0.986 [1.5784
D(IWS1SE(-	0.328 (0.276 [1.1878	1.131 (0.621 [1.8198	0.707 (0.581 [1.2170	0.668 (0.582 [1.1477	-0.4733 (0.869 [-0.5445	0.076 (0.902 [0.0842	0.080 (1.238 [0.0649	0.440 (0.859 [0.5122
D(PWS1SE(-1	-0.2801 (0.335 [-0.8340	-0.2313 (0.755 [-0.3060	1.105 (0.706 [1.5659	1.262 (0.707 [1.7846	0.699 (1.056 [0.6623	-0.8661 (1.097 [-0.7894	-0.4690 (1.504 [-0.3116	-1.9746 (1.045 [-1.8893
D(PWS1SE(-2	-0.2456 (0.274 [-0.8965	-1.1250 (0.616 [-1.8242	-0.6200 (0.576 [-1.0759	-0.5812 (0.577 [-1.0067	0.534 (0.862 [0.6201	-0.0477 (0.895 [-0.0533	-0.4325 (1.227 [-0.3522	-0.2425 (0.852 [-0.2844
D(ER1SE(-	0.106 (0.056 [1.8684	0.149 (0.128 [1.1673	-0.0098 (0.119 [-0.0826	-0.0050 (0.120 [-0.0420	-0.7064 (0.179 [-3.9425	-0.1594 (0.186 [-0.8566	-0.1418 (0.255 [-0.5559	0.190 (0.177 [1.0748
D(ER1SE(-	0.106 (0.061 [1.7191	0.128 (0.139 [0.9232	-0.2277 (0.130 [-1.7475	-0.2251 (0.130 [-1.7240	-0.0898 (0.194 [-0.4605	0.174 (0.202 [0.8633	-0.1747 (0.277 [-0.6293	0.181 (0.192 [0.9416
D(KR1SE(-	-0.0672 (0.056 [-1.1858	-0.1065 (0.127 [-0.8350	-0.4732 (0.119 [-3.9705	-0.4701 (0.119 [-3.9372	-0.0337 (0.178 [-0.1890	-0.5295 (0.185 [-2.8599	0.334 (0.253 [1.3190	0.311 (0.176 [1.7668
D(KR1SE(-	0.083 (0.057 [1.4602 2]	0.254 (0.128 [1.9733 0]	-0.0476 (0.120 [-0.3959 0]	-0.0450 (0.120 [-0.3736 6]	0.320 (0.180 [1.7807 8]	-0.2466 (0.187 [-1.3181 6]	0.020 (0.256 [0.0815 5]	-0.0401 (0.178 [-0.2254 7]

Vector Error Correction Estimates

D(IR1SE(-1))	-0.014993	0.133883	0.272610	0.272656	-0.105219	0.093770	-0.628793	0.095123
	(0.03961)	(0.08914)	(0.08330)	(0.08345)	(0.12461)	(0.12940)	(0.17748)	(0.12326)
	[-0.37849]	[1.50190]	[3.27278]	[3.26715]	[-0.84436]	[0.72464]	[-3.54286]	[0.77170]
D(IR1SE(-2))	-0.006666	0.125281	0.035768	0.036975	0.004652	0.155934	0.006116	0.068939
	(0.04516)	(0.10163)	(0.09496)	(0.09514)	(0.14207)	(0.14753)	(0.20234)	(0.14053)
	[-0.14761]	[1.23272]	[0.37665]	[0.38862]	[0.03274]	[1.05696]	[0.03023]	[0.49056]
D(PR1SE(-1))	0.005387	-0.164350	0.025682	0.025418	-0.055340	-0.126225	0.076104	-0.519534
	(0.05201)	(0.11703)	(0.10936)	(0.10956)	(0.16360)	(0.16989)	(0.23301)	(0.16183)
	[0.10358]	[-1.40432]	[0.23485]	[0.23199]	[-0.33826]	[-0.74299]	[0.32661]	[-3.21041]
D(PR1SE(-2))	0.099572	-0.071806	-0.045795	-0.045604	0.014645	-0.196503	0.012765	-0.215130
	(0.05353)	(0.12046)	(0.11256)	(0.11277)	(0.16839)	(0.17486)	(0.23983)	(0.16657)
	[1.86015]	[-0.59610]	[-0.40685]	[-0.40438]	[0.08697]	[-1.12374]	[0.05322]	[-1.29154]
C	-1.689152	0.426352	1.317989	1.972494	3.189846	1.696533	-0.593341	1.472862
	(1.39163)	(3.13169)	(2.92630)	(2.93184)	(4.37787)	(4.54610)	(6.23515)	(4.33041)
	[-1.21380]	[0.13614]	[0.45039]	[0.67278]	[0.72863]	[0.37318]	[-0.09516]	[0.34012]
R-squared	0.734847	0.528358	0.727317	0.689714	0.703686	0.681174	0.529593	0.435105
Adj. R-squared	0.589441	0.269715	0.577781	0.519558	0.541192	0.506334	0.271629	0.125323
Sum sq. resids	2738.109	13866.29	12107.14	12153.07	27097.58	29220.09	54966.52	26513.19
S.E. equation	9.398197	21.14946	19.76241	19.79986	29.56544	30.70152	42.10836	29.24490
F-statistic	5.053746	2.042810	4.863825	4.053407	4.330523	3.895981	2.052967	1.404554
Log likelihood	-168.0965	-207.8402	-204.5164	-204.6091	-224.2548	-226.1024	-241.5831	-223.7206
Akaike AIC	7.595774	9.217966	9.082301	9.086088	9.887950	9.963362	10.59523	9.866148
Schwarz SC	8.290728	9.912921	9.777255	9.781042	10.58290	10.65832	11.29018	10.56110
Mean dependent	-1.224490	0.000000	0.000000	0.816327	1.020408	1.020408	-1.020408	1.836735
S.D. dependent	14.66752	24.74874	30.41381	28.56548	43.64845	43.69615	49.33917	31.26989

Determinant resid covariance (dof adj.)	3.85E+16
Determinant resid covariance	9.89E+14
Log likelihood	-1402.159
Akaike information criterion	63.43507
Schwarz criterion	69.30357

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:56
Sample (adjusted): 4 52
Included observations: 49 after
adjustments Standard errors in ( ) & t

Cointegrating	CointEq
EWS1TF(-	1.00000
KWS1TF(-	1.04966 (0.3101 [3.3842
IWS1TF(-	-2.35173 (0.3296 [-7.1350
PWS1TF(-	0.52555 (0.2283 [2.3012
ER1TF(-	-2.28286 (0.4416 [-5.1692
KR1TF(-	-2.05754 (0.4088 [-5.0322
IR1TF(-	-0.34533 (0.1460 [-2.3648
PR1TF(-	2.14240 (0.2984 [7.1795
C	445.128

Error	D(EWS1TF)	D(KWS1TF)	D(IWS1TF)	D(PWS1TF)		D(KR1T	D(IR1T	D(PR1T
CointEq	0.08267 (0.0800 [1.0333	-0.23070 (0.0836 [-2.7571	0.08080 (0.0966 [0.8360	-0.11532 (0.1030 [-1.1188	0.07494 (0.1557 [0.4813	0.16759 (0.1463 [1.1451	0.38628 (0.1440 [2.6812	-0.34072 (0.1629 [-2.0915

Vector Error Correction Estimates

D(EWS1TF(-1	-0.51358 (0.1702 [-3.0162	0.02709 (0.1780 [0.1521	-0.11179 (0.2057 [-0.5434	-0.10994 (0.2193 [-0.5012	-0.00184 (0.3314 [-0.0055	-0.31102 (0.3114 [-0.9985	-0.00395 (0.3066 [-0.0128	0.15366 (0.3467 [0.4432
D(EWS1TF(-2	-0.00767 (0.1565 [-0.0490	-0.01157 (0.1636 [-0.0706	-0.24040 (0.1890 [-1.2715	0.19665 (0.2016 [0.9753	0.03565 (0.3046 [0.1170	-0.54396 (0.2862 [-1.9001	0.18274 (0.2818 [0.6484	-0.07077 (0.3186 [-0.2220
D(KWS1TF(-1	-0.01099 (0.1619 [-0.0678	-0.52776 (0.1693 [-3.1157	-0.15732 (0.1956 [-0.8040	0.01358 (0.2086 [0.0651	0.11066 (0.3152 [0.3510	-0.07052 (0.2962 [-0.2380	-0.42168 (0.2916 [-1.4458	-0.09039 (0.3297 [-0.2741
D(KWS1TF(-2	0.33952 (0.1592 [2.1323	-0.18552 (0.1665 [-1.1140	0.13875 (0.1923 [0.7213	-0.09122 (0.2051 [-0.4447	0.08613 (0.3099 [0.2779	0.09127 (0.2912 [0.3133	-0.13562 (0.2867 [-0.4730	0.23959 (0.3242 [0.7390
D(IWS1TF(-1	0.35883 (0.1762 [2.0358	-0.48690 (0.1843 [-2.6412	-0.30751 (0.2129 [-1.4441	-0.12160 (0.2270 [-0.5355	0.42520 (0.3430 [1.2394	-0.07375 (0.3224 [-0.2287	0.93764 (0.3174 [2.9541	-0.27372 (0.3588 [-0.7627
D(IWS1TF(-2	-0.09380 (0.1425 [-0.6580	-0.36873 (0.1490 [-2.4732	-0.28274 (0.1722 [-1.6418	0.15569 (0.1836 [0.8478	0.42817 (0.2774 [1.5432	0.11757 (0.2607 [0.4509	0.52343 (0.2566 [2.0391	-0.12886 (0.2902 [-0.4439
D(PWS1TF(-1	-0.23228 (0.1286 [-1.8053	0.23383 (0.1345 [1.7376	-0.10620 (0.1554 [-0.6832	-0.09924 (0.1657 [-0.5987	0.15334 (0.2504 [0.6123	-0.26426 (0.2353 [-1.1228	0.13433 (0.2317 [0.5797	0.21812 (0.2619 [0.8325
D(PWS1TF(-2	-0.01910 (0.1273 [-0.1500	0.22665 (0.1331 [1.7020	-0.07432 (0.1538 [-0.4831	0.00761 (0.1640 [0.0464	0.09773 (0.2478 [0.3943	0.04636 (0.2329 [0.1990	0.20714 (0.2292 [0.9034	0.19039 (0.2592 [0.7343
D(ER1TF(-1	0.28315 (0.1522 [1.8604	-0.44660 (0.1591 [-2.8054	0.11914 (0.1838 [0.6479	-0.17178 (0.1960 [-0.8760	-0.66742 (0.2962 [-2.2529	-0.06854 (0.2784 [-0.2461	0.67956 (0.2740 [2.4793	-0.76520 (0.3099 [-2.4690
D(ER1TF(-2	0.21101 (0.1040 [2.0279	-0.23769 (0.1088 [-2.1841	0.09136 (0.1257 [0.7268	-0.08361 (0.1340 [-0.6237	-0.72481 (0.2025 [-3.5788	-0.28374 (0.1903 [-1.4907	0.36702 (0.1873 [1.9587	-0.34225 (0.2118 [-1.6153
D(KR1TF(-1	0.11203 (0.1182 [0.9474	-0.30349 (0.1236 [-2.4538	0.06663 (0.1428 [0.4664	-0.09065 (0.1523 [-0.5950	0.08473 (0.2301 [0.3681	-0.58705 (0.2163 [-2.7139	0.42460 (0.2129 [1.9939	-0.49758 (0.2407 [-2.0665
D(KR1TF(-2	0.09260 (0.0759 [1.2197 5]	-0.18138 (0.0794 [-2.2843 5]	0.12126 (0.0917 [1.3221 0]	-0.11114 (0.0978 [-1.1363 5]	0.02194 (0.1477 [0.1485 1]	-0.53541 (0.1388 [-3.8554 1]	0.00948 (0.1367 [0.0693 7]	-0.12548 (0.1545 [-0.8117 4]

Vector Error Correction Estimates

D(IR1TF(-1))	-0.096060	-0.074247	0.105379	0.005627	-0.099535	-0.055735	-0.569193	0.110391
	(0.08387)	(0.08772)	(0.10133)	(0.10805)	(0.16325)	(0.15343)	(0.15104)	(0.17078)
	[-1.14530]	[-0.84637]	[1.03996]	[0.05207]	[-0.60971]	[-0.36327]	[-3.76852]	[0.64638]
D(IR1TF(-2))	-0.199773	-0.040830	-0.114413	0.209289	0.020725	-0.021073	-0.173471	0.016074
	(0.08287)	(0.08667)	(0.10012)	(0.10676)	(0.16130)	(0.15159)	(0.14923)	(0.16874)
	[-2.41067]	[-0.47107]	[-1.14279]	[1.96034]	[0.12849]	[-0.13902]	[-1.16242]	[0.09526]
D(PR1TF(-1))	0.021961	0.242119	0.060308	0.225858	-0.177086	-0.325899	-0.761866	-0.177751
	(0.13492)	(0.14111)	(0.16300)	(0.17381)	(0.26260)	(0.24680)	(0.24296)	(0.27472)
	[0.16277]	[1.71581]	[0.36999]	[1.29943]	[-0.67435]	[-1.32051]	[-3.13579]	[-0.64703]
D(PR1TF(-2))	-0.113648	0.222860	0.036164	0.102916	-0.099645	-0.020683	-0.457648	-0.233500
	(0.10321)	(0.10795)	(0.12469)	(0.13297)	(0.20089)	(0.18880)	(0.18586)	(0.21016)
	[-1.10112]	[2.06449]	[0.29002]	[0.77399]	[-0.49602]	[-0.10955]	[-2.46230]	[-1.11107]
C	-0.278654	0.531472	0.551269	0.017953	-0.215039	0.296730	-1.487832	0.464310
	(0.97068)	(1.01523)	(1.17270)	(1.25052)	(1.88930)	(1.77562)	(1.74798)	(1.97649)
	[-0.28707]	[0.52350]	[0.47009]	[0.01436]	[-0.11382]	[0.16711]	[-0.85117]	[0.23492]
R-squared	0.618174	0.570130	0.457462	0.383068	0.765432	0.823038	0.540364	0.652321
Adj. R-squared	0.408786	0.334395	0.159941	0.044750	0.636798	0.725994	0.288306	0.461658
Sum sq. resids	1374.573	1503.667	2006.283	2281.391	5207.412	4599.576	4457.529	5699.101
S.E. equation	6.658910	6.964580	8.044799	8.578651	12.96075	12.18086	11.99130	13.55883
F-statistic	2.952284	2.418522	1.537581	1.132272	5.950458	8.481090	2.143807	3.421332
Log likelihood	-151.2129	-153.4121	-160.4773	-163.6256	-183.8454	-180.8045	-180.0360	-186.0560
Akaike AIC	6.906649	6.996413	7.284790	7.413291	8.238589	8.114470	8.083100	8.328814
Schwarz SC	7.601604	7.691367	7.979744	8.108246	8.933543	8.809424	8.778055	9.023769
Mean dependent	0.000000	0.204082	0.204082	-0.204082	0.000000	0.408163	-0.204082	0.408163
S.D. dependent	8.660254	8.536636	8.777290	8.777290	21.50581	23.27008	14.21411	18.47963

Determinant resid covariance (dof adj.)	5.97E+14
Determinant resid covariance	1.53E+13
Log likelihood	-1300.053
Akaike information criterion	59.26748
Schwarz criterion	65.13598

Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:56
Sample (adjusted): 4 52
Included observations: 49 after
[illegible]

Cointegrating	CointEq
EWS1TF(-	1.0000
KWS1TF(-	1.0496 (0.310 [3.3842
IWS1TF(-	-2.35173 (0.329 [-7.1350
PWS1TF(-	0.5255 (0.228 [2.3012
ER1TF(-	-2.28286 (0.441 [-5.1692
KR1TF(-	-2.05754 (0.408 [-5.0322
IR1TF(-	-0.34533 (0.146 [-2.3648
PR1TF(-	2.1424 (0.298 [7.1795
C	445.12

Error	D(EWS1TF)	D(KWS1TF)	D(IWS1TF)	D(PWS1TF)		D(KR1T	D(IR1T	D(PR1T
CointEq	0.0826 (0.080 [1.0333	-0.23070 (0.083 [-2.7571	0.0808 (0.096 [0.8360	-0.11532 (0.103 [-1.1188	0.0749 (0.155 [0.4813	0.1675 (0.146 [1.1451	0.3862 (0.144 [2.6812	-0.34072 (0.162 [-2.0915

Vector Error Correction Estimates

D(EWS1TF(-1	-0.513585 (0.170 [-3.0162	0.0270 (0.178 [0.1521	-0.111796 (0.205 [-0.5434	-0.109948 (0.219 [-0.5012	-0.001848 (0.331 [-0.0055	-0.311028 (0.311 [-0.9985	-0.003953 (0.306 [-0.0128	0.1536 (0.346 [0.4432
D(EWS1TF(-2	-0.007670 (0.156 [-0.0490	-0.011570 (0.163 [-0.0706	-0.240408 (0.189 [-1.2715	0.1966 (0.201 [0.9753	0.0356 (0.304 [0.1170	-0.543967 (0.286 [-1.9001	0.1827 (0.281 [0.6484	-0.070770 (0.318 [-0.2220
D(KWS1TF(-1	-0.010992 (0.161 [-0.0678	-0.527767 (0.169 [-3.1157	-0.157324 (0.195 [-0.8040	0.0135 (0.208 [0.0651	0.1106 (0.315 [0.3510	-0.070525 (0.296 [-0.2380	-0.421685 (0.291 [-1.4458	-0.090391 (0.329 [-0.2741
D(KWS1TF(-2	0.3395 (0.159 [2.1323	-0.185528 (0.166 [-1.1140	0.1387 (0.192 [0.7213	-0.091229 (0.205 [-0.4447	0.0861 (0.309 [0.2779	0.0912 (0.291 [0.3133	-0.135622 (0.286 [-0.4730	0.2395 (0.324 [0.7390
D(IWS1TF(-1	0.3588 (0.176 [2.0358	-0.486901 (0.184 [-2.6412	-0.307517 (0.212 [-1.4441	-0.121602 (0.227 [-0.5355	0.4252 (0.343 [1.2394	-0.073752 (0.322 [-0.2287	0.9376 (0.317 [2.9541	-0.273728 (0.358 [-0.7627
D(IWS1TF(-2	-0.093805 (0.142 [-0.6580	-0.368733 (0.149 [-2.4732	-0.282747 (0.172 [-1.6418	0.1556 (0.183 [0.8478	0.4281 (0.277 [1.5432	0.1175 (0.260 [0.4509	0.5234 (0.256 [2.0391	-0.128864 (0.290 [-0.4439
D(PWS1TF(-1	-0.232287 (0.128 [-1.8053	0.2338 (0.134 [1.7376	-0.106204 (0.155 [-0.6832	-0.099241 (0.165 [-0.5987	0.1533 (0.250 [0.6123	-0.264263 (0.235 [-1.1228	0.1343 (0.231 [0.5797	0.2181 (0.261 [0.8325
D(PWS1TF(-2	-0.019102 (0.127 [-0.1500	0.2266 (0.133 [1.7020	-0.074325 (0.153 [-0.4831	0.0076 (0.164 [0.0464	0.0977 (0.247 [0.3943	0.0463 (0.232 [0.1990	0.2071 (0.229 [0.9034	0.1903 (0.259 [0.7343
D(ER1TF(-1	0.2831 (0.152 [1.8604	-0.446604 (0.159 [-2.8054	0.1191 (0.183 [0.6479	-0.171787 (0.196 [-0.8760	-0.667421 (0.296 [-2.2529	-0.068543 (0.278 [-0.2461	0.6795 (0.274 [2.4793	-0.765203 (0.309 [-2.4690
D(ER1TF(-2	0.2110 (0.104 [2.0279	-0.237693 (0.108 [-2.1841	0.0913 (0.125 [0.7268	-0.083617 (0.134 [-0.6237	-0.724810 (0.202 [-3.5788	-0.283746 (0.190 [-1.4907	0.3670 (0.187 [1.9587	-0.342250 (0.211 [-1.6153
D(KR1TF(-1	0.1120 (0.118 [0.9474	-0.303493 (0.123 [-2.4538	0.0666 (0.142 [0.4664	-0.090651 (0.152 [-0.5950	0.0847 (0.230 [0.3681	-0.587051 (0.216 [-2.7139	0.4246 (0.212 [1.9939	-0.497581 (0.240 [-2.0665
D(KR1TF(-2	0.0926 (0.075 [1.2197 5]	-0.181382 (0.079 [-2.2843 5]	0.1212 (0.091 [1.3221 0]	-0.111140 (0.097 [-1.1363 5]	0.0219 (0.147 [0.1485 1]	-0.535410 (0.138 [-3.8554 1]	0.0094 (0.136 [0.0693 7]	-0.125481 (0.154 [-0.8117 4]

Vector Error Correction Estimates

D(IR1TF(-1))	-0.096060	-0.074247	0.105379	0.005627	-0.099535	-0.055735	-0.569193	0.110391
	(0.08387)	(0.08772)	(0.10133)	(0.10805)	(0.16325)	(0.15343)	(0.15104)	(0.17078)
	[-1.14530]	[-0.84637]	[1.03996]	[0.05207]	[-0.60971]	[-0.36327]	[-3.76852]	[0.64638]
D(IR1TF(-2))	-0.199773	-0.040830	-0.114413	0.209289	0.020725	-0.021073	-0.173471	0.016074
	(0.08287)	(0.08667)	(0.10012)	(0.10676)	(0.16130)	(0.15159)	(0.14923)	(0.16874)
	[-2.41067]	[-0.47107]	[-1.14279]	[1.96034]	[0.12849]	[-0.13902]	[-1.16242]	[0.09526]
D(PR1TF(-1))	0.021961	0.242119	0.060308	0.225858	-0.177086	-0.325899	-0.761866	-0.177751
	(0.13492)	(0.14111)	(0.16300)	(0.17381)	(0.26260)	(0.24680)	(0.24296)	(0.27472)
	[0.16277]	[1.71581]	[0.36999]	[1.29943]	[-0.67435]	[-1.32051]	[-3.13579]	[-0.64703]
D(PR1TF(-2))	-0.113648	0.222860	0.036164	0.102916	-0.099645	-0.020683	-0.457648	-0.233500
	(0.10321)	(0.10795)	(0.12469)	(0.13297)	(0.20089)	(0.18880)	(0.18586)	(0.21016)
	[-1.10112]	[2.06449]	[0.29002]	[0.77399]	[-0.49602]	[-0.10955]	[-2.46230]	[-1.11107]
C	-0.278654	0.531472	0.551269	0.017953	-0.215039	0.296730	-1.487832	0.464310
	(0.97068)	(1.01523)	(1.17270)	(1.25052)	(1.88930)	(1.77562)	(1.74798)	(1.97649)
	[-0.28707]	[0.52350]	[0.47009]	[0.01436]	[-0.11382]	[0.16711]	[-0.85117]	[0.23492]
R-squared	0.618174	0.570130	0.457462	0.383068	0.765432	0.823038	0.540364	0.652321
Adj. R-squared	0.408786	0.334395	0.159941	0.044750	0.636798	0.725994	0.288306	0.461658
Sum sq. resids	1374.573	1503.667	2006.283	2281.391	5207.412	4599.576	4457.529	5699.101
S.E. equation	6.658910	6.964580	8.044799	8.578651	12.96075	12.18086	11.99130	13.55883
F-statistic	2.952284	2.418522	1.537581	1.132272	5.950458	8.481090	2.143807	3.421332
Log likelihood	-151.2129	-153.4121	-160.4773	-163.6256	-183.8454	-180.8045	-180.0360	-186.0560
Akaike AIC	6.906649	6.996413	7.284790	7.413291	8.238589	8.114470	8.083100	8.328814
Schwarz SC	7.601604	7.691367	7.979744	8.108246	8.933543	8.809424	8.778055	9.023769
Mean dependent	0.000000	0.204082	0.204082	-0.204082	0.000000	0.408163	-0.204082	0.408163
S.D. dependent	8.660254	8.536636	8.777290	8.777290	21.50581	23.27008	14.21411	18.47963

Determinant resid covariance (dof adj.)	5.97E+14
Determinant resid covariance	1.53E+13
Log likelihood	-1300.053
Akaike information criterion	59.26748
Schwarz criterion	65.13598

Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 01/10/18 Time: 13:48
Sample (adjusted): 4 52
Included observations: 49 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating	CointEq1
EWS1TU(-1	1.00000
KWS1TU(-1	0.55154 (0.6816 [0.80908
IWS1TU(-1	-0.700882 (0.4306 [-1.62767
PWS1TU(-1	1.87606 (0.5908 [3.17518
ER1TU(-1	0.63577 (0.2489 [2.55408
KR1TU(-1	0.61488 (0.1899 [3.23646
IR1TU(-1	-10.93355 (0.9190 [-11.8967
PR1TU(-1	0.69915 (0.2474 [2.82564
C	2051.05

Error	D(EWS1TU)	D(KWS1TU)	D(IWS1TU)	D(PWS1TU)		D(KR1T	D(IR1T	D(PR1T
CointEq1	-0.055204 (0.0591 [-0.93263	-0.062320 (0.0357 [-1.74218	0.00980 (0.0466 [0.21000	-0.122681 (0.0507 [-2.41850	-0.277545 (0.1237 [-2.24265	-0.190107 (0.1372 [-1.38507	0.12552 (0.0244 [5.14362	-0.181735 (0.1504 [-1.20772

Vector Error Correction Estimates

D(EWS1TU(-1))	-0.586442	0.129312	-0.251774	-0.103012	-0.285691	0.109724	-0.202001	-0.788291
	(0.17311)	(0.10461)	(0.13654)	(0.14835)	(0.36193)	(0.40141)	(0.07137)	(0.44008)
	[-3.38770]	[1.23609]	[-1.84392]	[-0.69438]	[-0.78934]	[0.27335]	[-2.83023]	[-1.79124]
D(EWS1TU(-2))	-0.495100	0.272047	0.022728	-0.253404	-0.005092	0.209376	-0.219175	-0.459214
	(0.19260)	(0.11639)	(0.15191)	(0.16505)	(0.40268)	(0.44659)	(0.07941)	(0.48962)
	[-2.57066]	[2.33736]	[0.14961]	[-1.53531]	[-0.01264]	[0.46883]	[-2.76015]	[-0.93790]
D(KWS1TU(-1))	-0.006331	-0.799638	-0.048948	-0.188747	0.052887	1.396575	-0.101447	-0.171059
	(0.22081)	(0.13344)	(0.17417)	(0.18923)	(0.46166)	(0.51201)	(0.09104)	(0.56134)
	[-0.02867]	[-5.99250]	[-0.28104]	[-0.99746]	[0.11456]	[2.72763]	[-1.11433]	[-0.30473]
D(KWS1TU(-2))	-0.042978	-0.633076	-0.282606	0.041338	0.272023	0.596157	-0.091642	-0.546109
	(0.22061)	(0.13332)	(0.17401)	(0.18906)	(0.46124)	(0.51154)	(0.09096)	(0.56083)
	[-0.19482]	[-4.74861]	[-1.62410]	[0.21865]	[0.58976]	[1.16541]	[-1.00755]	[-0.97375]
D(IWS1TU(-1))	-0.433823	0.241600	-0.422540	-0.078365	0.118290	0.333566	0.176446	0.492628
	(0.23525)	(0.14217)	(0.18556)	(0.20161)	(0.49187)	(0.54551)	(0.09699)	(0.59807)
	[-1.84406]	[1.69937]	[-2.27709]	[-0.38870]	[0.24049]	[0.61147]	[1.81913]	[0.82370]
D(IWS1TU(-2))	-0.069090	0.075544	0.135180	0.140075	-0.220880	0.289742	0.292019	0.768293
	(0.20460)	(0.12364)	(0.16138)	(0.17534)	(0.42777)	(0.47443)	(0.08436)	(0.52014)
	[-0.33769]	[0.61098]	[0.83764]	[0.79889]	[-0.51635]	[0.61072]	[3.46175]	[1.47710]
D(PWS1TU(-1))	0.109329	-0.242607	-0.185218	-0.232765	0.954705	0.162034	-0.254613	0.431395
	(0.18124)	(0.10953)	(0.14296)	(0.15532)	(0.37894)	(0.42026)	(0.07473)	(0.46076)
	[0.60322]	[-2.21500]	[-1.29562]	[-1.49861]	[2.51943]	[0.38555]	[-3.40732]	[0.93628]
D(PWS1TU(-2))	0.164120	-0.050856	0.081092	0.129781	0.502181	0.544835	-0.031077	0.747854
	(0.19059)	(0.11518)	(0.15033)	(0.16333)	(0.39849)	(0.44195)	(0.07858)	(0.48453)
	[0.86110]	[-0.44154]	[0.53942]	[0.79457]	[1.26021]	[1.23280]	[-0.39548]	[1.54347]
D(ER1TU(-1))	-0.023531	0.015490	-0.013855	0.043022	-0.577313	-0.331850	-0.095745	0.184693
	(0.08680)	(0.05246)	(0.06846)	(0.07439)	(0.18148)	(0.20127)	(0.03579)	(0.22066)
	[-0.27110]	[0.29529]	[-0.20237]	[0.57837]	[-3.18114]	[-1.64877]	[-2.67538]	[0.83699]
D(ER1TU(-2))	-0.012387	0.004276	0.072704	-0.028635	-0.004264	0.040572	0.029216	0.561998
	(0.08860)	(0.05354)	(0.06989)	(0.07593)	(0.18525)	(0.20545)	(0.03653)	(0.22525)
	[-0.13981]	[0.07987]	[1.04032]	[-0.37712]	[-0.02302]	[0.19748]	[0.79978]	[2.49504]
D(KR1TU(-1))	0.030156	-0.028081	-0.073410	0.093268	0.274548	-0.573934	-0.083032	0.122011
	(0.07669)	(0.04635)	(0.06049)	(0.06573)	(0.16035)	(0.17784)	(0.03162)	(0.19498)
	[0.39319]	[-0.60587]	[-1.21350]	[1.41904]	[1.71215]	[-3.22723]	[-2.62585]	[0.62578]
D(KR1TU(-2))	0.016618	-0.027763	-0.037782	0.227841	0.039760	0.004848	-0.048956	-0.050157
	(0.07485)	(0.04523)	(0.05904)	(0.06414)	(0.15649)	(0.17355)	(0.03086)	(0.19027)
	[0.22203]	[-0.61380]	[-0.63998]	[3.55220]	[0.25408]	[0.02793]	[-1.58647]	[-0.26361]

Vector Error Correction Estimates

D(IR1TU(-1))	-0.271223	-0.122585	-0.102511	-0.761947	-1.155719	-1.933116	0.609976	-1.216808
	(0.44433)	(0.26852)	(0.35047)	(0.38078)	(0.92900)	(1.03032)	(0.18320)	(1.12959)
	[-0.61041]	[-0.45652]	[-0.29249]	[-2.00100]	[-1.24404]	[-1.87623]	[3.32962]	[-1.07721]
D(IR1TU(-2))	-0.199364	-0.153116	-0.491382	-1.062845	-0.041271	-2.022777	0.077125	-0.966374
	(0.40172)	(0.24277)	(0.31686)	(0.34426)	(0.83991)	(0.93151)	(0.16563)	(1.02125)
	[-0.49628]	[-0.63071]	[-1.55078]	[-3.08730]	[-0.04914]	[-2.17151]	[0.46566]	[-0.94626]
D(PR1TU(-1))	0.091137	0.063115	-0.124799	-0.035669	-0.059892	0.343016	-0.062054	-0.797549
	(0.08610)	(0.05203)	(0.06791)	(0.07379)	(0.18002)	(0.19965)	(0.03550)	(0.21889)
	[1.05848]	[1.21297]	[-1.83761]	[-0.48340]	[-0.33270]	[1.71807]	[-1.74805]	[-3.64365]
D(PR1TU(-2))	-0.005956	0.018904	-0.125287	-0.023416	-0.365849	-0.024037	-0.104907	-0.573261
	(0.08698)	(0.05256)	(0.06860)	(0.07454)	(0.18185)	(0.20168)	(0.03586)	(0.22111)
	[-0.06847]	[0.35966]	[-1.82622]	[-0.31415]	[-2.01181]	[-0.11918]	[-2.92545]	[-2.59260]
C	0.491315	-0.032844	-0.268459	-0.315156	-0.173208	-0.401138	0.256926	-0.383424
	(1.20690)	(0.72936)	(0.95197)	(1.03429)	(2.52338)	(2.79858)	(0.49760)	(3.06821)
	[0.40709]	[-0.04503]	[-0.28200]	[-0.30471]	[-0.06864]	[-0.14334]	[0.51633]	[-0.12497]
R-squared	0.467504	0.704614	0.660592	0.658873	0.729632	0.642194	0.823190	0.600276
Adj. R-squared	0.175489	0.542628	0.474465	0.471803	0.581366	0.445978	0.726230	0.381073
Sum sq. resids	2182.149	796.9404	1357.633	1602.600	9539.016	11733.11	370.9403	14102.90
S.E. equation	8.389988	5.070281	6.617749	7.190048	17.54167	19.45475	3.459164	21.32914
F-statistic	1.600961	4.349841	3.549144	3.522074	4.921097	3.272892	8.489963	2.738447
Log likelihood	-162.5360	-137.8575	-150.9091	-154.9733	-198.6755	-203.7476	-119.1214	-208.2547
Akaike AIC	7.368816	6.361531	6.894248	7.060134	8.843896	9.050921	5.596792	9.234886
Schwarz SC	8.063770	7.056485	7.589203	7.755088	9.538851	9.745875	6.291746	9.929841
Mean dependent	0.204082	0.204082	0.000000	-0.204082	-0.612245	0.408163	0.204082	-0.612245
S.D. dependent	9.239813	7.497165	9.128709	9.893136	27.11151	26.13739	6.611164	27.11151

Determinant resid covariance (dof adj.)	1.78E+14
Determinant resid covariance	4.58E+12
Log likelihood	-1270.450
Akaike information criterion	58.05917
Schwarz criterion	63.92767

Abstract

SUPPLY CHAIN ANALYSIS OF MARINE FISH MARKETING SYSTEM IN KERALA

By

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ABSTRACT OF THE THESIS

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ABSTRACT

Fisheries is a major allied sector of agriculture contributing about 0.8 per cent to the Gross Domestic Product (GDP) and 5.15 per cent to agricultural GDP in India. Marine fisheries supports around 10 million people providing livelihood and employment directly or indirectly. Fish also provides more than one billion people living below the poverty line with most of their daily animal protein requirement globally. Kerala is a state known for its fish consumption which is more than four times the national average. However, the marine domestic fish marketing system faces several challenges in the process of distributing fish from the producer to the consumer.

The study was conducted in Kerala state, which is the fourth largest fish producer in the country, and covered coastal and land locked (non-coastal) regions. The objectives of the study were to identify the supply chain of selected fish species, to assess the structure and performance of domestic fish markets, to examine the market integration and price transmission among the markets and to assess the consumer perception and suggest policy guidelines for improved fish marketing in Kerala. Two coastal districts viz., Ernakulam (E) and Kollam (K) and two land locked districts, Idukki (I) and Pathanamthitta (P) were selected and data was collected using simple random sampling from various marketing functionaries (producers, wholesalers, retailers and consumers). Since the species composition of marine fish landings is varied, the study focused on four high value (seer fish, shrimp, pomfret and tuna) and four low value but commonly consumed fish species (sardine, mackerel, anchovies, threadfin bream).

Supply chain of the selected fish species was identified using the framework of Feller *et al*, 2006. Market performance of producers, wholesalers and retailers were assessed using Data Envelopment Analysis. The co-integration test was used to analyses the market integration of selected market pairs. Conjoint analysis was used to determine the attributes responsible for their fish purchasing behaviour. The constraints faced by the market functionaries were ranked using Rank Based Quotient.

The generic supply chain of fish identified involved the auctioneer, wholesaler, retailers, secondary retailers, between the producer and the consumer. This is almost similar to the supply chain of other perishable like fruits, vegetables and flowers. The supply chain for sardine, tuna and thread fin bream also involved extra nodes in their supply chain due to industry specific demands like feed and other specialized products. The market structure of

domestic fish markets was not efficient. The main reason being lack of infrastructure such as cold storage, well planned display and assemblage platforms, potable water and weighing balance.

Market performance of producers was measured at the five landing centres in Ernakulam and Kollam and it was observed that only one market was efficient in each of the districts. It was revealed that the nature of inefficiency was due to scale rather than technology. In both Ernakulam and Kollam, only one wholesale market each was efficient and all other markets showed high technical efficiency i.e., above 0.80. In both wholesale and retail markets, the technical efficiency was relatively low in Idukki and Pathanamthitta with it being least in Idukki. It was revealed that the markets in the coastal regions showed relatively high technical efficiency than the land locked regions because of the higher volumes handled in the markets due to proximity with the landing centres, viz, the primary production centres, which is not so easily accessible to the land locked districts. Among wholesale markets, one market pair in Ernakulam, one in Idukki and one in Pathanamthitta showed co-integration and among retail one each in Ernkulam and Pathanamthitta showed co-integration. This indicates that in these markets there is a possibility of long run equilibrium in prices. The existence of low short run market integration (SRMI) at both wholesale as well as retail market levels was observed among the co-integrated market pairs.

Consumer preference was for fresh fish in all the four districts studied in cleaned and cut form from retailers, wholesalers or wholesaler-cum-retailer. Sardine was the most preferred species in both coastal and landlocked regions of Kerala with more than 75 and 72 per cent of respondents, respectively, consuming it daily. The relative importance of attributes that consumer in Ernakulam and Kollam looked at while purchasing fish was fish species in fresh form and income. In Idukki and Pathanamthitta, availability and income were the relatively important attributes. Based on the pooled response of market functionaries in the selected districts the domination of middlemen was the major constraint for producers, wholesalers and retailers. Safety and quality of fish was the major constraint of consumers. The studies on efficiency of fish supply chain in line with the changing consumer preference are the future line of work towards sustainable fisheries development.