Market chain analysis for the trade in live reef food fish

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ABSTRACT

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Market chain analysis can provide information on distribution of costs and profits to intermediaries and identify concentrations of market power. This paper explores market chain issues for the live reef food fish trade, a high-value export fishery involving nearly 20 countries in the Asia-Pacific region, with demand centred in Hong Kong. The characteristics of the trade mean the market chain is more extended than most seafood chains. With supply dominated by artisanal fishers in developing countries, there are concerns that gains are being unevenly distributed along the chain. This paper describes the market chain for live reef fish and identifies key cost, revenue and risk components that may affect the distribution of value along the chain.

1. Introduction

For most seafood products there are usually numerous intermediaries along the market, or value chain between the primary producer (fisher) and the consumer. Market chain analysis in the resource sector has historically been undertaken in the agricultural sector with information provided on profitability and margins experienced by the various intermediaries, hereinafter referred to as agents, along the market chain (Kaplinsky, 2000; Fitter and Kaplinsky, 2001, Stevens, 2001). More recently, considerable research has been undertaken on price and margin relationships and transmission of price variability along European seafood chains, specifically cod and salmon (Asche et al., 2002; Hartmann et al., 2000; Gonzales et al. 2002; Guillotreau, 2003).

We have been able to find no such studies dealing with tropical fisheries of the Asia-Pacific region with the exception of Jacinto (2004) who describes a research framework for value chain analysis in small-scale fisheries in the Philippines. This paucity of research on tropical fisheries is likely to be a result of data limitations in these fisheries due to the geographic remoteness of fishing grounds, the large number of landing sites, the range of fishing gears and limited monitoring and enforcement capacity of governments (Christensen and Pauly, 1998; Pauly, 1998). This paper is part of a larger project that aims to analyse economic and market impacts of the live reef food fish (LRFF) trade in Asia-Pacific. The project is funded by the Australian Centre for International Agricultural Research (ACIAR). Outcomes from this paper, along with related project components examining supply and demand, will contribute to the development of a partial equilibrium model of the LRFF trade. This paper aims to identify and measure the key cost and revenue components in the product marketing chain and to incorporate risk factors into market chain models by considering, identifying and measuring the:

a) relative size and distribution of value along the market chain
b) risk borne by various agents
c) price relationships and the transmission of price information along this chain.

The last of these most commonly relies on the use of co-integration analysis to delineate markets (Engle and Granger, 1987; Gordon et al., 1993, Asche et al., 1997). The application of these econometric techniques to this project will be hindered by the paucity and quality of data available for each intermediary level and the length of time over which these data extend.

For a) and b) above, primary and secondary data will be used to develop models of the market chain from the point of capture to the point of sale. These models will aid managers of capture fisheries and the aquaculture sector to assess the future viability of the fisheries under their jurisdiction.

The paper proceeds as follows: Section 2 provides a background to market chains. Section 3 provides a background to LRFF trade in supply and demand countries in the context of the market chain, including its extent and a descriptive overview of agents along the chain. Section 4 presents empirical data on prices, costs incurred (e.g. freight, processing) and revenues along the LRFF chain of custody. Section 5 is a brief discussion of the theory of price and margin relationships and transmission of price variability in the context of characteristics and nature of the trade that limit the application of these econometric techniques. The final section discusses these empirical data in the context of technological and infrastructural improvements that could precipitate the geographic expansion of the trade, or lead to greater volumes being traded.

2. The Market Chain

The terms market chain and economic value chain are considered interchangeable for the purpose of this paper. A ‘value chain’ is a description of the full range of activities required to bring a product through different stages of production, through to delivery to consumers, and then disposal (Kaplinsky and Morris, 2003). Market chain analysis aims to provide information on profitability for the various agents along the market chain (Ferris et al., 2001). Economic value chain analysis describes the range of activities required to bring a product to the final consumer and, in the case of international products, the extent to which intermediaries/agents gain from participating in the chain (Jacinto, 2004). A traditional food industry value chain consists of the producer, processor, wholesaler, exporter, importer, retailer and consumer.

In fisheries such as the LRFF trade, where unsustainable fishing practices are in use, international trade can pose significant risks to valuable ecosystems and social and economic sustainability (Sadovy and Vincent, 2002; Sadovy et al., 2004). Paradoxically, high-value fisheries such as the LRFF trade offer a potential source of much needed income for local fishing communities. Market chain analysis can help to identify constraints (e.g. information flows), inequities (distribution of value) and practices (e.g. handling, quality control) along the chain that can serve to enhance benefits of trade to agents, especially those in source countries.

A number of factors determine the percentage of the final value extracted at certain points along the market chain, in particular market chain complexity and risk. Complexity refers to the

collective number of agents in the supply chain in exporting and importing countries (MacFadyen et al., 2003). The complexity of the market chain may expand or contract depending on the country of product origin, market sophistication / maturity and the distance of fishing grounds (i.e. fisher) from major infrastructure (storage and transport facilities). Remoteness, along with handling and husbandry techniques, will also dictate the risk of product loss faced by the various agents. (See Sadovy and Vincent (2002) for a discussion about poor handling and husbandry practices.) Other factors that influence distribution of value include: a) the amount of processing required to prepare a product for consumer markets; b) storage and transportation requirements of the product; and c) the perishable nature of the product.

Profit margins may show a steady increase moving downstream along the chain from fisher to retailer, or they may be haphazardly distributed along the chain. More processing results in a greater percentage of the final value accruing to processors: usually at the expense of the raw material supplier (fisher). Where the product is transported in fresh or frozen form, a greater contribution of final value tends to accrue to wholesalers and distributors. Finally, where the product is perishable in nature, as with LRFF, the value extracted by retailers is greater. As an example, a value chain for unprocessed protein might generate 25% for retailers, 25% for wholesalers/distributors, leaving 50% for producers. Alternatively, the value chain for processed products would provide 40% for retailers, 35% for wholesalers/distributors, and 5% for processors leaving 20% for producers (Wolfe, 2002).

There is a paucity of literature about, and limited empirical data on, product market chains, profit margins and the distribution of value along chains in developing countries. Supply chains for marine ornamental fish export trade in the Philippines and Indonesia have been examined (Wood, 2001; MacFadyen et al., 2003). The Food and Agriculture Organisation (FAO) (van Anrooy, 2003) examined cooperation and market performance for finfish aquaculture in Vietnam, while Jacinto (2004) presented a research framework for value chain analysis for small-scale Philippines fisheries. Some of the key elements identified in these case studies are discussed in the following sections.

3. Pricing and price transmission

The number of agents and market structures at each stage of the chain can affect the transmission of information about demand, and hence price, along the chain. Moreover, the difference between prices received by fishers and prices paid by consumers tends to increase the more agents (middlemen) in the market chain (MacFadyen et al., 2003). A lack of transparency in price setting and limited access to market and price information, especially at the primary producer level, is one of the main causes of price inequity. Also, the oligopolistic nature of markets at the buyer (middlemen, wholesaler/exporter) level of the market chain raises the possibility for price collusion (van Anrooy, 2003). Oligopolistic markets are those that have few buyers with one or more buyers able to influence the market and other buyers.

Agents will respond uniquely to changes in relative prices. In general, changes in consumer demand can be gradually distorted down the chain so that derived demand for the seafood differs substantially from consumer demand (Asche et al., 2002). For this project, the issue is whether price changes are being transmitted along the market chain and, if so, how various agents along

the chain might respond to price changes. For example, are fishers varying their effort in response to price, or are their effort levels consistent regardless of price changes with the principal outcome of price changes being the increased margins received by downstream agents along the chain?

4. Distribution of value and risk

The distribution of value of marine products is recognised as an issue of great concern in developing country export fisheries, both in terms of the percentage of final value accruing to agents along the chain and the under-pricing of resources. Final consumer prices should reflect true costs of fish catches in terms of externality costs imposed on communities from overexploitation of their resources (Jacinto, 2004). Even so, profit margins and value need to be considered in the context of risk borne by the respective agents along the market chain.

In the case of wild-caught fisheries it has been suggested that fishers are usually poorly paid based on the final value of seafood products (Wood, 2001). However several factors would give explanation for their receiving a relatively smaller percentage of final value. The remoteness of fishing grounds and small individual catches requires middlemen who can consolidate catches into sufficient quantities for export and direct collector efforts to meet exporter needs. Often these middlemen provide credit to fishers in the form of gear etc. to facilitate their fishing activities, although credit arrangements are usually not 'mutually beneficial'.

For export fisheries, financial risks increase as the product moves along the market chain. The middlemen bear the costs of holding fish post-harvest. The costs of transportation to markets are borne by middlemen, wholesalers and exporters and/or importers. Shipping and freight costs can make up between 50–66% of landed price paid by importer, while at the consumption end of the chain, retailers incur considerable costs (e.g. rent, wages) (MacFadyen et al., 2003). The greater downstream risks of financial losses from mortality, prior to the product reaching consumer markets, partly explains the inequitable distribution of value.

For aquaculture fisheries it has been shown that processors receive larger absolute returns while the aquaculture farmers recieve the largest relative returns of the agents along the market chain. Margins for wholesalers and retailers appear constant over time (van Anrooy, 2003). Margins in the ornamental trade tend to be fixed at all stages of the market chain above collector level.

Market structures in developing fisheries with complex market chains tend to be fixed such that reducing links in the market chain to benefit small-scale fishers is unlikely to be possible (MacFadyen et al., 2003). Also, governance and distributional outcomes are often skewed toward agents, such as wholesalers and exporters, thereby marginalising small-scale fishers. Horizontal integration, where adjacent communities or aquaculture farms form cooperatives, could enhance bargaining power and lead to improved returns.

While horizontal cooperation at various stages along the chain does occur, economic relations in a fishery product chain are generally vertical. Vertical cooperation is essential in fishery chains because of perishability of the product, variations in product quantity and quality, consumer awareness of product quality and food health issues, and differences in economies of scale that

constrain vertical integration. These issues highlight the need for improved flow of, and increased access to, market information, and to better storage and transport practices along the product chain (van Anrooy, 2003).

The key objectives of vertical cooperation in the market chain are generating larger profits for cooperatives through increased market share, improved product quality and product branding. An example of this is the higher price paid for Australian fish entering the LRFFT because of their quality. Opportunities for vertical cooperation are likely to be greater in controlled environments such as finfish aquaculture where benefits are easier to generate due to the ability of supply to meet: variant demand conditions, increased access to product quality information, easier implementation of quality control activities, and increased access to credit (van Anrooy, 2003).

5. The market chain for live reef food fish

The market for live fish is longstanding in Southeast Asia, although the LRFF trade first began in the mid 1970s. The demand for LRFF is concentrated in Hong Kong and China with more than 20 countries in Southeast Asia and the Pacific supplying fish to this market. As the traditional sources of LRFF in the South China Sea began to show signs of over-exploitation, the trade expanded into new areas; firstly in Southeast Asia and more recently the Indo-west Pacific (Sadovy et al., 2004) (Figure 1).

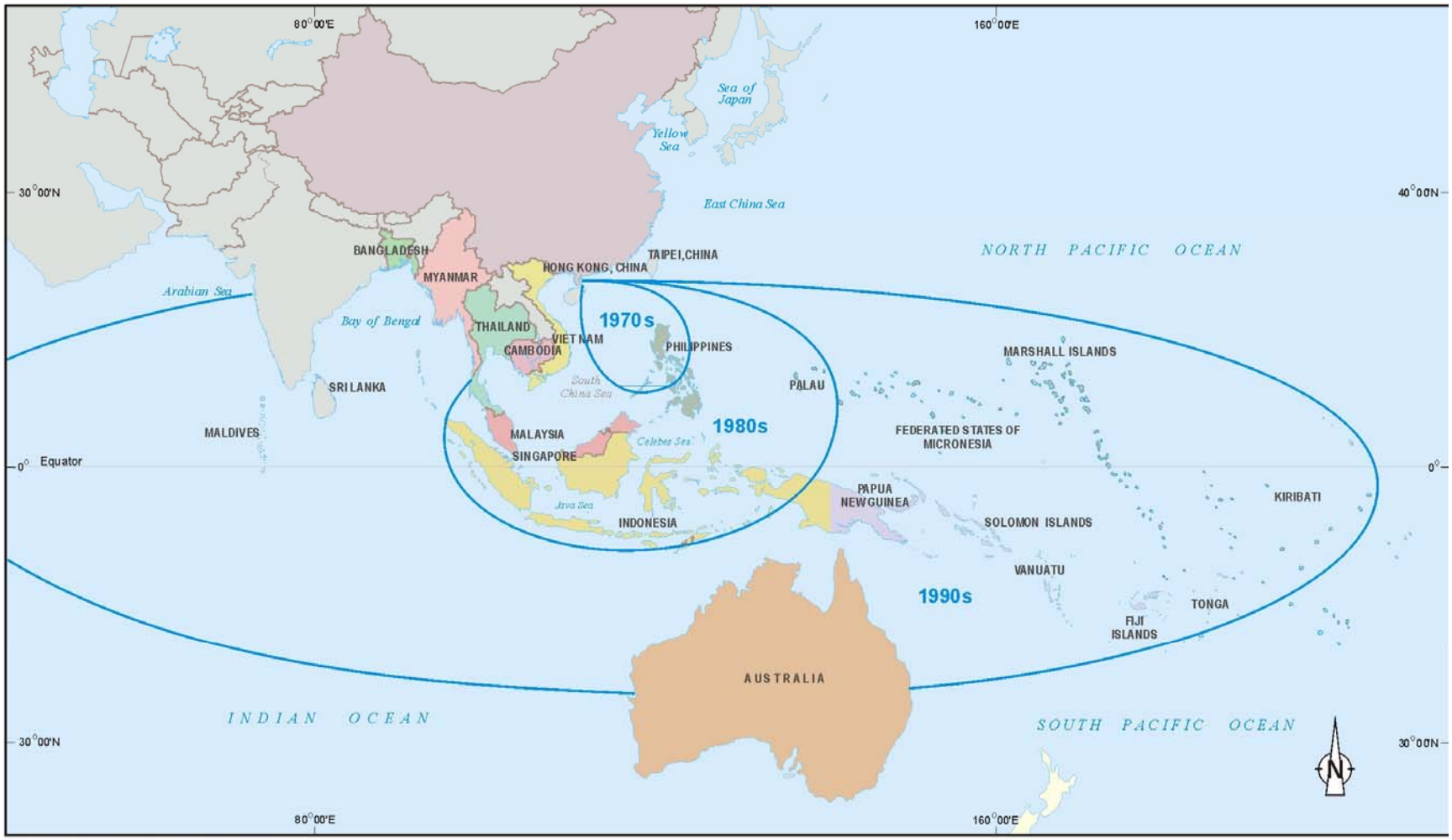
As a high value commodity there is a perceived potential for high economic gains along the chain. Indeed, the high price of LRFF in Hong Kong has created an impression among suppliers in importing countries that the price they receive from buyers one step along in the chain is too low (Chan, 2001). However, in this extended market chain for LRFF, each agent requires an acceptable margin to continue trading. In practice these gains tend to be unevenly distributed among agents for a variety of reasons including: fishers' lack of knowledge of final values; high transport costs incurred by traders when shipping fish across large distances either by sea or air; the high risks of mortality endured by traders during transport; health scares (e.g. ciguatera); and shocks in economic conditions (e.g. an outbreak of Severe Acute Respiratory Syndrome (SARS)).

The characteristics of the LRFF trade, such as its international scope, undeveloped storage and transport infrastructure, low technology of gear and the distances of source countries from markets, have resulted in the market chain for LRFF becoming quite extended. For example, the costs of shipping a consignment of LRFF may cost in excess of one-quarter of million US dollars, an outlay unaffordable to retailers. The trade itself is complex with LRFF passing through many levels of trade between the fisher and the restaurant (Figure 2).

The market chain can be shorter in some countries than in others. In Southeast Asia, the supply side of the market chain includes one or two middlemen whose role is to consolidate catches from independent fishers into sufficient quantities for movement along the chain. There are no middlemen in Australia: fish are passed from fishing firms who employ fishers to wholesaler/exporters. The chain is historically shorter still in the Pacific with fishers being employed directly by exporters, who tranship almost entirely by sea.

Traditionally there are diverging interests between upstream (fishers) and downstream (consumer) agents. Fishers seek the highest possible prices, while downstream agents (wholesalers, exporters, importers) are better able to integrate into organised marketing channels and contracts. The interests themselves are not diverging, everyone wants the highest price. It is the access to channels and contracts that seems to differ. This usually infers a greater market power by those intermediaries further down the chain. The predominantly artisanal and subsistence nature of fishermen in the LRFF trade, with the exception of those in Australia, tend to exacerbate this concentration of market power.

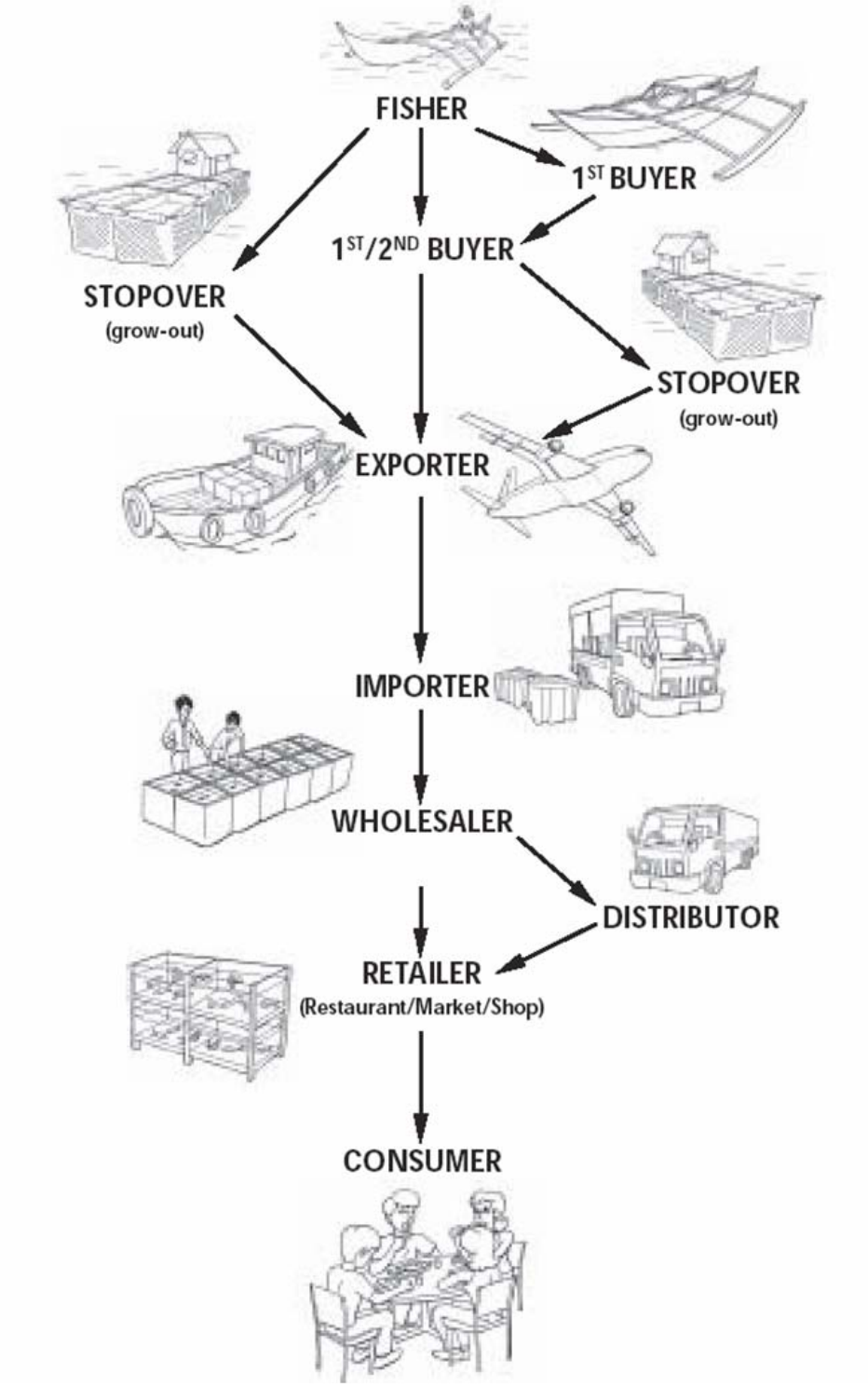
Figure 1: Source countries for live reef food fish imported into Hong Kong, showing the expansion of the trade in successive decades into both the Indian and Pacific Oceans.



Note: Boundaries are not necessarily authoritative.

Source: Sadovy et al. (2004)

Figure 1: The trade structure for live reef food fish from fisher to consumer.



Source: (Sadovy et al., 2004)

6. The market chain and operational costs for wild-caught live reef fish

Capital investment in fishing vessels and gear varies across countries. In Australia, capital costs range from US$100,000 to US$450,000 (Sadovy et al., 2004). This contrasts with the average investment in the Philippines of US$700 for smaller operations, and up to US$2000 for larger boats capable of travelling farther and supporting more fishers (Padilla et al. 2003). Comparable investment costs and financial arrangements exist in Indonesia. Exporters and dealers usually extend financial assistance to fishers to enable such investment with repayments deducted directly from fishers' wages or catch revenue until the loan is repaid. During difficult times, fishers are often extended credit to supplement living costs.

The main costs incurred by dealers/brokers and exporters in establishing LRFF capture and export operations are in the construction of the land-based holding facilities or floating cages, and the purchase of vessels, motors, and other fishing equipment. Identifying these costs is complicated by the trading structures within and between countries that involve several parties between sea and restaurant (Bentley, 1999). Floating cage construction costs in Indonesia are estimated to be around US$2500 per unit, while in Vietnam these costs range from A$800 to US$1200 (Bentley and Indrawan, 1999). In the Philippines, fish for grow-out are held in floating cages while fish ready for export are held in floating cages and land-based facilities; cage capital costs are estimated to be approximately US$1250 (Baliao et al, 2000). Capitalisation of land-based facilities in the Philippines is estimated at US$25,000–30,000 while in Australia, land-based facility costs are around US$200,000.

The traditional mode of transporting LRFF to markets was by ship operated by importers in Hong Kong. These special purpose live transport vessels range in size from 20–40 meters and are capable of transporting 12–20 tons of live fish over 10,000 kilometers on voyages lasting 25–30 days. LRFF importers operate one or more live-fish carriers. Foreign agents in exporting countries are responsible for collecting and consigning adequate quantities of fish for export. One 15 tonne shipment of LRFF may cost importers up to US$250,000. Larger importers may own floating cage stations in Hong Kong and will also act as wholesalers if they have a large holding capacity.

Improved shipping skills and technology (i.e. aerated transport bins) has seen a marked increase in the volume of fish being transported to Hong Kong markets by air from all major exporting countries. About 60% of all LRFF imported there now arrive by air. From Indonesia, almost 40%,in some areas up to 70%, of all LRFF are sent by air. From Australia, Malaysia, and the Philippines nearly all LRFF exports are delivered to Hong Kong by air. Thailand and Vietnam also rely heavily on air transport, with up to half of all exports being transported by this means (Bentley, 1999; Chan, 2000; Padilla et al., 2003).

Modes of air transport differ widely. LRFF exported from Southeast Asia are transported in oxygenated plastic bags packed in polystyrene boxes. Exports from Australia are transported in large, moulded plastic, aerated or oxygenated bins. The latter can hold up to 300 kg of fish in 1 m^3 of water; almost five times the capacity of the polystyrene boxes. While transporting LRFF in bins is more cost-effective than polystyrene boxes, the cost of returning these bins to the originating exporter is high, adding considerably to the overall cost of freight.Polystyrene boxes

used to transport fish from many Southeast Asian countries also represent an operating cost to buyers/exporters. These boxes are not re-used after reaching Hong Kong.

The cost to wholesaler/exporters of getting live product to Hong Kong usually consists of: the 'beach' price paid to fishers or middlemen; wage costs; fixed costs such as electricity and maintenance; and freight costs. Freight costs may include the cost of returning an empty transport bin to its point of origin. The costs of air-freighting LRFF to Hong Kong from Australia has been estimated at between $6.20 and $13.35 per kilogram depending on whether aerated or oxygen bins are used, with oxygen bins having greater capacity; the number of bins shipped at any one time; and the mode of transport by which bins are returned to Australia (Table 1).

Table 1: Freight costs to wholesale exporter transporting live fish from Cairns to Hong Kong. Costs include shipment to Hong Kong and bin return either by sea or air (All costs are in A$).

No Bins	Total Cost (A$)	Capacity # of fish		Cost/kg (A$)		Bin Ret (A$)		Total costs/kg ($A) Bin return by sea		Total costs/kg (A$) Bin return by air	
		Aeration	Oxygen	Aeration	Oxygen	Sea	Air	Aeration	Oxygen	Aeration	Oxygen
1	1600	240	300	6.67	5.33	525	1000	8.85	7.10	13.35	10.65
2	3185	480	600	6.64	5.31	1050	1900	8.80	7.05	13.25	10.60
3	4355	720	900	6.05	4.84	1575	3000	8.25	6.60	12.10	9.70
4	5325	960	1200	5.55	4.44	2100	4000	7.75	6.20	11.10	8.90

Source: Goodsview Trading; Wholesale Fish Buyer, Cairns Queensland, unpublished data .

Within Australia, composite operational costs (fixed annual and variable) of land-based facilities have been estimated at approximately A$10.00/kg of fish exported (L. Peterson, pers. comm.) The total cost to the exporter of obtaining and transhipping LRFF to Hong Kong is estimated at between A$46.50 and A$53.50/kg. These estimates are based on the assumption that exports consist solely of coral trout given that this species has comprised 90–95% of all Australian exports. A beach price of A$30/kg, based on average annual prices received by fishing operators for 2000/2001, was used. This cost can be compared against the average annual wholesale price in Hong Kong for live coral trout in 2000–01 of between A$60–65 (IMA Hong Kong, unpublished data).

Changes in transport technology and practices (see Sadovy et al., 2004) have resulted in lower rates of mortality along the market chain between export and import countries. Mortality during use of transport bins is reported to be <5% on average compared to 30–50% for sea transport (L. Petersen, K. Vy, and P. Chan, pers. comm.). The uptake of transport bins has reduced holding times in source countries and transhipment times (from weeks to days). Furthermore, LRFF arrive in Hong Kong in better condition when air transport is used. Cage maintenance and associated holding costs (wages, feed etc.), while generally low in most developing countries, are difficult to quantify and vary according to the length of time fish are held prior to export. Holding

times for LRFF sent by air are approximately 7–10 days from first sale, including reconditioning fish during transit. The greater volume of fish required to justify using a live-fish transport vessel means longer holding times and higher holding costs. Overall improvements in transport technology have reduced investment risks and improved cash flows for importers and exporters (Table 2).

Table 2: Transport and operating costs by transport mode for main export countries.

Region / Country	Operating Costs (US$/kg)		Transport Costs (US$/kg)	
	Broker	Exporter	Air	Sea
Southeast Asia				
Indonesia	n/a	n/a	3.00–3.50	4.50–5.00 [a]
Philippines [b]	0.01	0.02	3.70–4.70	4.50–5.00 [a]
Malaysia	n/a	n/a	1.50–2.00	4.50–5.00 [a]
Vietnam [b]	0.03	0.05	~ 3.00	4.50–5.00 [a]
Oceania				
Australia	not applicable	6.50	7.05[c] / 8.80[d]	n/o
Fiji Islands		n/a	n/o	6.00–7.00 [e]
PNG/Solomon Islands		n/a	n/a	4.00–4.50 [e]
Indian Ocean				
Seychelles		n/a	n/o	6.00–7.00 [e]
Maldives		n/a	n/o	4.70–5.40 [e]

[a] Costs depend on quantity collected, fuel prices, and weather conditions affecting transportation times.
[b] Costs are daily costs per kilogram and include wages, fish food, and maintenance.
[c] Costs per kilogram by oxygenated bin (including cost of returning bin to origin).
[d] Costs per kilogram by aerated bin (including cost of returning bin to origin).
[e] Costs are based on a transport vessel capable of carrying up to 20 t, collecting 12–15 t of fish.
Note: n/a indicates data not available for that country while n/o means the mode of transport is not an option from that country.
Source: Sadovy et al. (2004)

As the quantity in each air shipment is relatively small, some retailers have started importing LRFF, avoiding the need to go through wholesalers. As a consequence, distinguishing between importers, wholesalers and retailers has become more difficult, although wholesalers retain the leading role in the trade (Chan, 2001).

6. The market chain and operational costs for cultured live reef fish

Aquaculture has been identified as an alternative livelihood to engaging in fishing practices that are often destructive. Aquaculture is also a means of meeting future demand for grouper species at a time when stocks of this species in Southeast Asia are showing signs of severe depletion. It is estimated that approximately 40 per cent of all LRFF are supplied from aquaculture, although the majority of these fish come from grow-out of wild-caught juveniles to market size (Sadovy et al.,

2004). With regard to the LRFF trade, aquaculture covers a range of activities from full-cycle aquaculture to grow-out of wild-caught juvenile and sub-adults for markets.

The market chain for aquacultured LRFF is not dissimilar to that of wild-caught LRFF, with the primary difference being during the production stage. Aquaculture of LRFF may involve several production stages and sectors. In Taipei for example, the production of eggs from broodstock, rearing of eggs, rearing of juveniles and grow-out of fish to market size are overseen by individual agents (Liao et al., 1994). Similar production chains have appeared in Indonesia where clusters of 'backyard' hatcheries and land-based grow-out facilities co-exist. Some of the operators of these facilities on-sell juveniles to larger grow-out farms (Siar et al., 2002). While culture production of groupers is expanding into other Southeast Asian countries, including the People's Republic of China, the Philippines, Thailand and Vietnam, it is still largely based on the collection and grow-out of wild-caught juveniles (Sadovy et al., 2004). Within these countries, grow-out of grouper occurs both in land-based ponds and in coastal cages. Previous studies of grouper aquaculture have shown hatcheries and grow-out facilities to be highly profitable, with high internal rates of return (Baliao et al., 2000; Siar et al., 2002; Haylor et al., 2003).

Table 3: Costs and revenues for humpback grouper hatchery production (all figures in US dollars).

Scale	3 hatchery runs of 100,000 viable eggs
Survival rate	5% of 300,000 (15,000 eggs)
Income	US$ 9,000 ($0.60 per fingerling)
Annual operating costs	US$4,750
Maintenance (3% of Capital costs)	US$ 200
Financial costs (18% interest on capital)	US$1,200
Total Annual Cost	US$6,140
Total Annual Profit	US$2,860

Source: Siar et al. (2002).

6. Fish mortality and transhipment costs (risk)

Fish mortality is not factored into the costs of transportation or the distribution of wealth among stakeholders (Table 3). Mortality remains a major factor, however, in the cost of delivering LRFF to markets to Hong Kong. Most fish deaths occur during the holding phase in the source country and during the transhipment phase.

The use of sea transport to deliver LRFF to markets usually requires the fish be held in floating cages for up to one month after capture. Mortality during the holding phase has been estimated to average as high as 50% between reef and retail, with estimates of up to 30% during the first 3–5 days of captivity. During these early phases, mortality is often the result of cyanide use, but has also been attributed to poor cage conditions, overstocking of cages, poor handling and feeding practices, and the spread of disease (Sadovy and Vincent, 2002).

While costs of shipping fish often compare favourably against shipping by air (see Table 2), they are tempered by two factors: the health of the fish, and supply and demand. As noted above, subsequent mortality is much lower when fish are freighted by air; mortality rates when using air transport bins are reported to average less than 5%. Mortality, particularly with sea transportation, is usually factored into the buying price at the import destination and is dictated by the condition of fish when collected, distance to market, and the supplier's history. Another factor dictating price is weight lost during transit, which can be as much as 15% (P. Chan, pers. comm. 2002). Large live transport vessels (LTVs) shipments of up to 15 tonnes of LRFF may oversupply the market driving down price and eroding profits to the live fish trader.

7. The market chain – exporting country prices

Wholesale or beach prices

The beach price refers to the amount paid by the buyer for a fish when it reaches shore, prior to export. Wholesaler/middlemen and exporters in source countries, and importers in Hong Kong, pay higher prices for plate-size fish, while oversize fish fetch a slightly lower price. In Australia, fish less than the legal minimum length of 38 cm are rejected by wholesalers, while in the Philippines and Indonesia, where size limits are not enforced or not in place, all fish are purchased. Fish that are undersize receive around one quarter of the price paid for a good size fish (Padilla et al. 2003. Fish not ready for markets are moved to grow-out cages where they are held until they reach plate-size (and their value has increased). Payment may be made directly to a sole fisher or paid to a fishing operation that employs several fishers. The export price is generally the amount paid to the exporter by the overseas buyer, usually based in Hong Kong,. This price will reflect costs incurred by the exporters to purchase fish from a broker/dealer, where applicable, as well as any holding and transportation costs incurred by the exporter.

Average beach prices received by fishers in the major exporting countries are shown in Table 4. The high prices paid for humphead wrasse in the Philippines and Malaysia recognise their proximity to market and the use of live-fish transport vessels to ship them. The significantly lower prices paid to Indonesia fishers for these high-value species does not reflect the high retail prices they attract. The lower price range for coral trout in Malaysia and the Philippines refers to undersize fish. While Filipino fishers are occasionally paid higher prices than fishers in Australia, Philippine catch rates are considerably lower than those in Australia. Padilla et al. (2003) estimate fishers on Coron catch 0.4 kg of fish/hour, while Mapstone et al. (2001) estimate that Australian fishers catch roughly 3.6 kg/hour. These prices do not reflect any obligations the fisher may have with the dealer to whom they sell their catch. The complexity of the market chain and the diverse relationship between fishers and dealers/buyers in different countries means that comparing beach price across countries is difficult.

A hypothetical market chain showing distribution of the final value of LRFF amongst the various agents along the chain is illustrated in Figure 3 (a) and (b).

Table 4: Average beach prices (US$) paid to fishers for selected species in the main exporting countries for 1999–2001

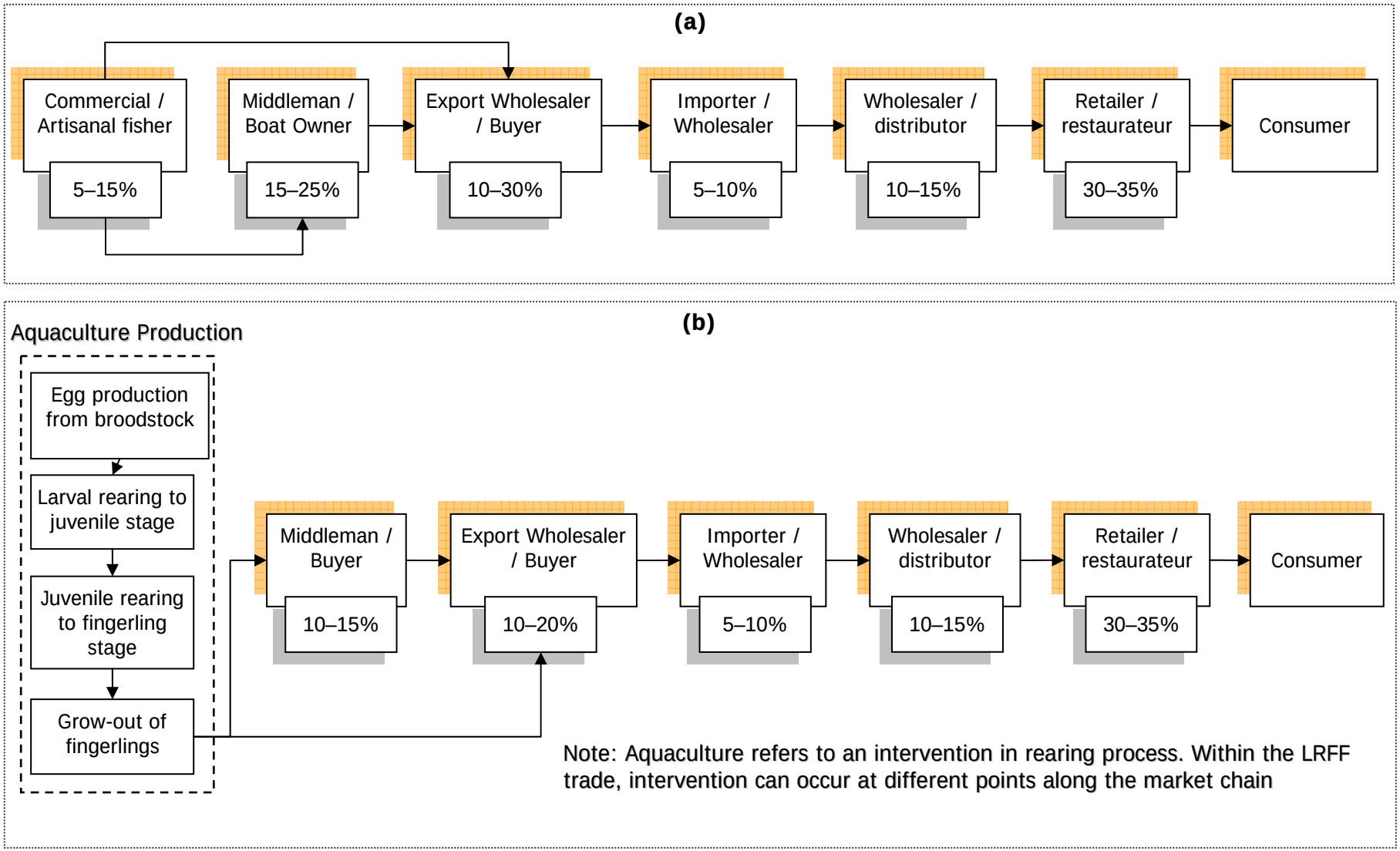
Species	Country	Beach Price ($/kg)		
		1999	2000	2001
Humphead wrasse	Philippines[a,b]	45–50	55–60	55–60
	Indonesia[c]	8–10	10–15	10–15
	Australia[d]	9–10	8–9	9–10
	Malaysia[e]		55–60	55–60
Highfin grouper	Philippines[a,b]	45–50	55–60	55–60
	Indonesia[c]	8–13	10–15	10–15
	Australia[d]	~ 29	~ 26	~ 24
Leopard coral trout	Philippines[b,f]	8–28	7–27	7–27
	Indonesia[c]	6–10	6–12	6–12
	Australia[d]	12–26	12–33	14–25
	Malaysia[e]	10–25	10–25	10–25
	Vietnam[f]		10–17	10–15
Tiger / flowery grouper	Philippines[b]	7–12	8–12	8–12
	Indonesia	1–2	1–2	1–2
	Australia[d]	5–6	4–6	3.5–5
Green Grouper	Philippines			8–9
	Indonesia	1–2	1–2	1–2
	Vietnam[g]		5–9	6–10
	Thailand[h]	5–8	5–8	5–8

[a] Beach price paid per piece.
[b] Total price paid by wholesaler/exporter. Fisher receives approximately 30% of total price and dealer 70% (Palawan Council for Sustainable Development).
[c] Price varies depending on location; fishers in some areas receive less than half of the price paid by dealers in other parts of Indonesia (Erdmann and Pet, 1999).
[d] Total prices paid to vessel owner. Fisher receives 20% of market value for all species.
[e] Lower price ranges are for undersized fish (< 0.5 kg) for grow-out. Upper range is for good size fish (0.5–1.0 kg) ready for market (Chan, unpublished data).
[f] Lower price ranges are for undersized fish (< 0.5 kg) for grow-out. Upper range is for good size fish (0.5–1.0 kg) ready for market. For fish greater than 1.0 kg price is paid per piece (Bentley, 1999).
[g] McCullough and Phung Giang (2001); IMA Viet Nam (unpublished data).
[h] Lower price ranges are for smaller fish for grow-out. Upper range is for good size fish (0.5–1.0 kg) ready for market (Chan, unpublished data).

Notes:
These data have been verified where possible by the Hong Kong, China, Chamber of Seafood Merchants.
Prices do not take into account any other deductions made by the buyer for debts owed.

Source: Sadovy et al., (2004)

Figure 2: Hypothetical Economic Value Chain Model for: a) wild-caught live reef food fish and b) farmed live reef food fish. The percentage represents the estimated % of the consumer dollar extracted at that link of the chain.



Source: Muldoon, unpublished data.

8. The market chain – case studies

Case studies of distribution of final value have been undertaken in Australia and the Philippines. In Australia, fishers retain a greater percentage of the final value because they don't bear variable costs associated with the fishing activity (i.e. hooks, bait, food and fuel). Filipino fishers must not only meet these costs but also pay instalments to financiers for debts for capital equipment; costs are deducted from the catch values before payment to the fishers (Table 5). Australian boat owners, effectively brokers, retain a smaller percentage of the final value than do their Filipino counterparts because they do not receive payment from fishers for use of capital equipment and their fixed and variable costs are higher. Lower net final values in Australia are attributed to higher transport and holding costs. High percentages attributed to end-users (restaurants) are due to high business costs.

Table 5: Wealth and income distribution along the market chain, based on average monthly retail and wholesale values (US$) in Hong Kong for Leopard coral trout

Australia (Great Barrier Reef, Queensland)

	Fisher	Boat owner	Exporter	Importer/ Retailer	End user	Final value
Share of Gross ($)	3.50	12.10	20.40	12.65	20.20	68.85
Share of Gross (%)	5.1	17.6	29.6	18.4	29.3	100.0
Net/kg ($)	3.50	2.40[a]	9.75[b]	1.75[c]	10.10[d]	27.50

[a] Based on boat-owner retaining about 20% of gross after fixed and variable fishing costs.
[b] Based on exporter retaining about 40% of gross after fixed and variable costs of storing and transporting live fish by air.
[c] Based on importer retaining about 20% of gross after fixed and variable costs of storing and transporting live fish to retail markets
[d] Based on restaurateur retaining about 50% of gross after payment of fixed and variable costs.

Philippines (Coron)

	Fisher	Middleman /Dealer	Exporter	Importer /Retailer	End user	Final value
Share of Gross ($)	7.80	15.70	11.80	10.95	22.60	68.85
Share of Gross (%)	14.3	22.9	14.3	15.9	32.8	100.0
Net/kg ($)	2.35[e]	7.85[f]	7.10[g]	2.00[h]	11.80[i]	31.10

[e] Based on fisher retaining about 30% of gross after debt repayment and fuel, bait etc purchase.
[f] Based on dealer retaining about 50% of gross after fixed and variable costs of storing and transporting live fish, (fisher debt repayment not included).
[g] Based on exporter retaining about 60% of gross after costs of storing and transporting live fish by air
[h] Based on importer retaining about 20% of gross after fixed and variable costs of storing and transporting live fish to retail markets.
[i] Based on restaurateur retaining about 50% of gross after payment of fixed and variable costs.

Note: Retail = $68.85 prices from Feb. 2001 and based on sale of a market-size fish weighing 0.5–1.0 kg.

Source: Sadovy et al. (2004)

9. Developing a market chain model

The key objective of this project component has been to measure cost and risk components of the market chain to enable comparison of returns to small scale fishers. The authors believe there are two approaches to deriving what constitutes a fair economic return:

i) A bottom-up approach of determining the costs of catching fish to derive a '*fair*' beach price that captures this cost plus a suitable margin.

ii) A top-down approach based on the equitable distribution of the final product value (i.e. retail price) between agents based on risks and costs (e.g. transport, holding etc.).

Developing a bottom-up market chain model for the LRFF fishery is problematic for two related reasons. Firstly, there is a paucity of usable data, with few exceptions, that would enable a market chain model to be fully populated. Secondly, vertical integration between agents hampers the development of discrete sub-models for specific agents (Sadovy et al., 2004). The initial spreadsheet models developed have used a hybrid top down approach consisting of two sub-models: one for fishers and fishing operations and the other for remaining market chain agents consisting of exporters, importers, distributors and retailers.

The fisher sub-model allows for costs to be derived using effort parameters and total revenues to be derived using catch parameters. Revenues can be based on either empirical beach price data or by using a margin-based approach, again using empirical evidence. Beach prices can also be used to derive margins based on costs. Total cost and revenue information are subsequently used to develop indicators of economic returns including: net present value; annualised returns; internal rates of return and rates of return on capital.

In recognition of the lack of data available, a simplified model has been adopted developed to schematically represent the supply chain. The current model incorporates wholesaler/exporter, importer/distributor and retailer margins based on limited empirical evidence. The model allows for these margins to be adjusted exploring the impacts of different margins on returns to agents and also to aid in examining the issue of 'fair price'.

Margins and value need to be considered in the context of risk borne by the respective agents along the market chain. Within the LRFF, financial risks increase as the product moves along the market chain with middlemen and exporters bearing mortality risks and the costs of holding fish post-harvest. The costs of storage and transportation to markets are also borne by middlemen, wholesalers and exporters and/or importers[1]. At the consumption end of the chain retailers incur considerable rent and wage costs (Chan 2001). The greater downstream risks of financial losses from mortality, prior to the product reaching consumer markets, can explain the existence of inequitable distribution of value.

Within the spreadsheet model, risk has been incorporated both for the fisher/fishing vessel and the supply chain sub-models. Within the fisher/fishing vessel sub-model, two types of risk have been accounted for: fish catches and fish prices. The first can account for increases or decreases in catches as a result of policy (management regulations) or environmental (overfishing) factors.

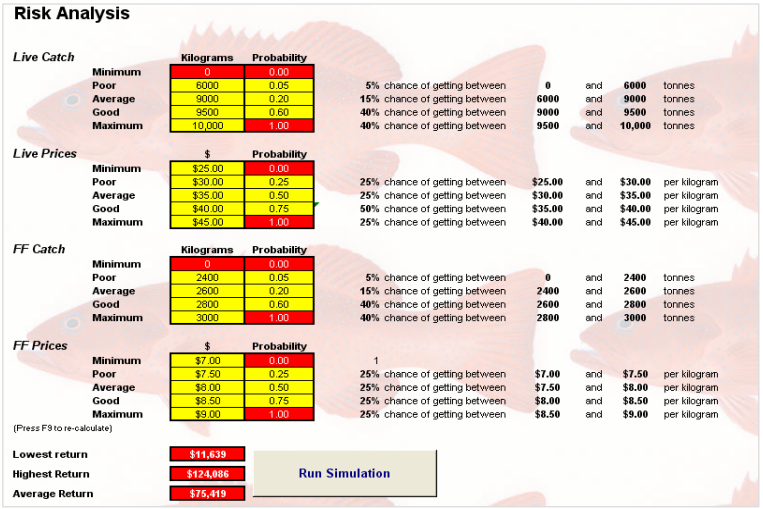
[1] Shipping and freight costs can make up between 50–65% of landed price paid by importer.

The second recognises changes in demand that influence prices. Within the supply chain model, risk is associated with mortality, exchange rate fluctuations and downstream price expectations. Risks have been accounted for using an expected value probability model.

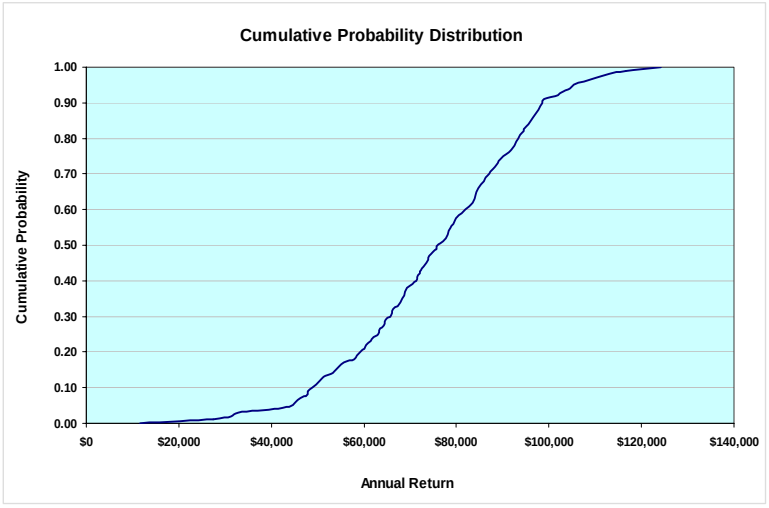
For each of the various risk components, an expected probability approach is used to calculate an expected value under a range of anticipated outcomes (Figure 4a). These expected values are used in turn to generate a cumulative probability distribution (Figure 4b). In the case of the fishing operation, risk analysis models have been incorporated for price and catch. These are reflected in the annual returns to the vessel (Figure 3). For exporters and importers, it is intended that risk analysis will be incorporated in the form of estimating expected survival rates for a consignment of live fish. The cumulative probability distribution will likely be expressed in terms of both volume (quantity) and value of a consignment and also as an annual return based on the number of monthly or annual consignments.

Figure 4: Risk analysis for fishing vessels which: (a) uses expected probabilities of a range of catch and fish price scenarios to estimate lowest, highest and average annual returns; and (b) generates a cumulative probability distribution of expected annual returns

(a)



(b)



9. Price co-integration – issues for further research?

Several studies have examined prices and margins along seafood chains, including the impacts of technological change (e.g. aquaculture) on these chains. Most studies use co-integration analysis to examine long-run relationships (Ferreira Dias et al., 2003 Asche et al., 2002; Guillotreau, 2003). The success of co-integration analysis depends on the availability of long-term and non-stationary time series price data (Gonzales et al., 2002). Most co-integration studies have examined large-scale industrial fisheries with good datasets, as opposed to small-scale artisanal fisheries. Co-integration techniques can be used to examine price variability, either upstream (closer to producer) or downstream (closer to retailer) by testing relationships between price margins or mark-ups (i.e. proportionality along the chain) and the strength of price transmission (Hartmann et al., 2000). Further procedures can test for *weak exogeneity* of prices to establish which segment of the market chain is influencing prices along the chain. Note that exogeneity does not imply price-setting status for the agent whose price is exogenous, it is more the direction in which price is being transmitted. For example, retailers may allow suppliers to set their prices based on variable fishing costs, and not consumer demand, with these costs in turn driven by stock and effort constraints. Thus greater variability in upstream prices may be due to: i) uncertainty driven exogeneity of prices; and ii) retailer pricing polices, whereby standard profit margins are added to supply costs with this behaviour amplified where products are more perishable (Gonzales et al. 2002)

Research has shown that price volatility is often not transmitted along the chain with various processors and wholesalers acting as buffers for producers (i.e. fishers). Lower price variability closer to downstream (consumer) markets is more common with processed products; while price transmission is more likely where downstream prices drive market forces (Gonzales et al., 2002). Product form can dictate the strength and pace of price transmission with transmission more evident for processed as opposed to fresh fish, due probably to the supply of fresh fish being more inelastic to price due to supply responses being hampered by biological and weather constraints (Petersen et al. 2004). Lastly, price adjustments tend to be transmitted more rapidly (especially to consumers) for farmed as opposed to wild-caught products, most likely due to greater production certainty faced by various agents along the market chain for cultured product. Overall, price transmission remains competitive and consumers benefit from increased availability of farmed fish (Guillotreau, 2003; Tveteras and Kvaloy, 2003, van Anrooy, 2003).

Empirical and anecdotal evidence available for the LRFF trade suggests that the direction and strength of price transmission is in contrast to that described for European fresh fish markets. The normal transmission of prices is distorted by convoluted business relationships along the chain, with fishers financially beholden to middlemen and exporters in supply countries who in turn are beholden to importers or wholesalers in importing countries. Price collusion in exporting and importing countries often may mean price-setting is controlled by downstream agents (e.g. retailers and wholesalers. Ideally, prices should move mutually in the long-run, allowing for marketing costs. For price-cost margins that are not constant over time, the cause may be market power, transaction costs (e.g. freight) or other more fundamental structural problems.

No studies have tested for market integration within the LRFF trade. Such research is hindered by a lack of reliable time-series data but further investigation is desirable.

10. Conclusions

Live reef food fish are a high value commodity in the under-developed and historically low-income regions from where many of these fish are sourced. Value-adding fisheries such as these can offer much needed income opportunities for the fishing communities in these regions. An extended market chain has developed between the upstream suppliers (fishers) and downstream buyers and distributors in the LRFF trade due to a number of factors, such as the use of low technologies and remoteness of fishing grounds. With the extended market chain for LRFF, the gains at each point along the chain have tended to be unevenly distributed for a variety of reasons including limited market information, value of capitalised assets, non-responsive behaviour by fishers in source countries, fluctuating market conditions and distribution of risk. These distortions along the market chain have been further complicated by increasing supplies of cultured fish as direct substitutes for wild-caught species.

The first step in understanding the market chain issues, such as relative margins accruing to upstream and downstream agents, price transmission and market power, is to undertake co-integration analysis. While sufficient data is available to examine price interactions in demand markets, with the exception of Australia, there is a paucity of usable data from supply markets. Cointegration analysis of the LRFF trade using available data will allow some preliminary exploration of the argument that market power resides at the downstream end of the market chain.

In support of co-integration analysis, models of costs and risk along the market chain can be used to understand exogenous influences arising from the adoption of new transportation and and production technologies, specifically: i) the supplanting of traditional sea with air transport, which may lessen ecological impact [2], lower transport costs and lower holding mortality. In the likely event of limited data being available for use in quantitative analyses, qualitative and scenario-based assessments of the LRFF trade market chain could be undertaken to: i) determine the constraints in the market chain that are hindering linkages and devise strategies and methods to remove or mitigate these constraints..

[2] With fewer fish required per shipment, opportunities for a small-scale fishery that is both economically and ecologically viable present themselves.

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