MODELING AND PROJECTION OF FISH SUPPLY AND DEMAND IN MALAYSIA, 2000-2020

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ABSTRACT

The fishery sector in Malaysia is expected to play important roles in eradicating poverty, increasing food security and helping to reverse the deficit food trade balance. In the Third Malaysian National Agriculture Policy Plan, the production target for the sector is to increase from 1.45 million mt in 2000 to two million mt by 2010. Adapting from the AsiaFish model, a disaggregated fish supply and demand model for Malaysia is constructed to analyse whether the fishery sector can live up to the expectations. The model consists of the producer, consumer and trade cores as well as the model closure equation. It is used to project fish supply, demand and trade in Malaysia from 2000 to 2020, given that existing conditions in the fishery sector and general economy persist into the future. The results appear to indicate that the Malaysian fishery sector may not be able to make significant contribution to the objectives above. Efforts need to be stepped up in order to increase fish production, reducing fish prices and increasing net value of fish trade.

Keywords: Fish supply; Demand; Trade; Price; Projection.

I. INTRODUCTION

Traditionally, the fishery sector in Malaysia plays important roles in alleviating poverty and in achieving food security. In 2003, this sector contributed about 1.37 percent to the country's GDP and provided direct employment to about 89,000 fishers and 21,000 fish farmers (Department of Fisheries, 2003). Fish is a main protein food for the majority of Malaysians and has contributed positively to the export earnings of the country.

In his keynote speech at the Seminar on the Balance of Trade Plan for the Agricultural and Food Industries, the Minister of Agriculture and Agro-Industry of Malaysia stated that the trade balance in the food sector was observed to be increasingly negative, from a deficit of RM1 billion in 1990 to about RM6.6 billion in 2004. Without public policy intervention, this negative food bill is likely to increase substantially to about RM10.9 billion by 2010. Among the agricultural sub-sectors, meat and meat preparations, animal feed, dairy products, cereals, vegetables and sugar are contributing significantly to the negative trade balances. On the other hand, fish, poultry, spices and tea are making positive contributions to the food sector. Increasing supply and export earnings from the fishery sector are expected to play a significant role in counter-balancing the negative food trade bills for Malaysia.

In the Third Malaysian National Agriculture Policy Plan, the production target for the fishery sector is to increase from 1.45 million mt in 2000 to two million mt by 2010 (Department of Fisheries, 2004). The bulk of the increase in production will be derived from aquaculture, with an expected increase of almost three-folds during this period and deep-sea capture fishery is expected to increase by two folds increase in fish production. On the other hand, the production target for coastal in-shore fishery is expected to decrease by about 20 percent during this period mainly because fisheries resources in the in-shore areas of Malaysia have been seriously overexploited.

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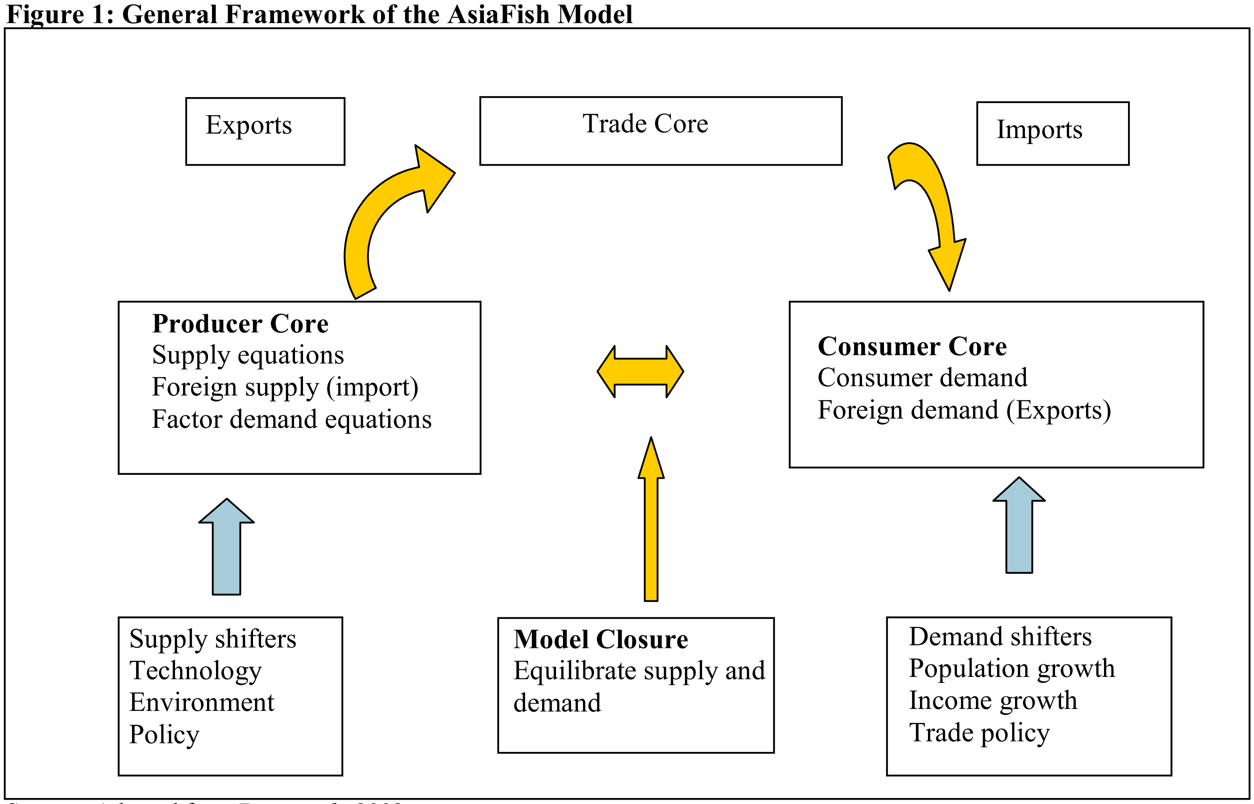
With these high expectations, it is of utmost important to investigate to what extent the Malaysian fishery sector is able to meet these challenges through making projections of the fish supply, demand and trade in Malaysia. To date, such a comprehensive analysis has not yet been done for Malaysia although such study on a global basis was first conducted by Delgado, *et al.* (2003). Thus in this paper, a supply and demand model for the Malaysian fisheries was constructed for making these projections for the period from 2000 to 2020.

II. THE BASIC STRUCTURAL MODEL

The Malaysian fisheries supply and demand model is an adaptation of the AsiaFish model developed by Dey, *et al.* (2003). The AsiaFish model is designed for generating detailed results on supply, demand, trade and prices for the fisheries sector. It is a partial equilibrium model, which assumes that the quantities and prices of non-fish commodities are exogenous to the system.

The general structure of the model is presented in Figure 1. This model is divided into producer, consumer and trade cores as well as the model closure condition. The domestic supply of a particular fish type is sourced from domestic production and imports. This is then allocated among households (consumption), firms (intermediate demand) and exports. The prices of fish types in the domestic market are derived by a series of supply and demand equilibrium conditions. In instances where the fish type categories in the supply and demand sides do not match, the model also has a set of linking equations that facilitate the disaggregation for use with the equilibrium conditions.

Figure 1: General Framework of the AsiaFish Model



Source: Adapted from Dey, *et al.*, 2003.

The producer core recognizes that the domestic supply of fresh fish comes from different sources namely marine capture, brackishwater aquaculture, and freshwater aquaculture. The output supplies and input demands of the fresh fish are determined jointly within each domestic source. This results in a series of equations in which the dependent variables are determined simultaneously by fish prices, input prices, and technology. Where necessary, the equations may also be adjusted for non-price determinants of output supply and input demand. The netput supply functions are derived from the normalized quadratic profit function as follows (Ball, *et al.*, 1997; Shumway, *et al.*, 1987):

$$\pi^* = \alpha_0 + \sum_i \alpha_i PE_i^* + \sum_k \alpha_{0k} v_k^* + \frac{1}{2}\left(\sum_i \sum_j \beta_{ij} PE_i^* PE_j^* + \sum_k \sum_l \beta_{kl} v_i^* v_j^* \right) + \sum_i \sum_k \gamma_{ik} PE_i^* v_k^* \quad (1)$$

Applying Hotelling's Lemma, the output supply functions are:

$$qs_i^* = \alpha_{0i} + \sum_j \alpha_{ij} PE_j^* + \sum_k \beta_{ik} v_k^* + e_i^* \quad (2)$$

The input demand functions are:

$$qx_i^* = -\left(\alpha_{0i} + \sum_j \alpha_{ij} PE_j^* + \sum_k \beta_{ik} v_k^* + e_i^* \right) \quad (3)$$

and the numeraire demand is:

$$qx_M^* = -\left[\left(\alpha_0 + \sum_k \alpha_{0k} v_k^* + \frac{1}{2} \sum_k \sum_l \beta_{kl} v_k^* v_l^* \right) + \frac{1}{2} \sum_i \sum_j \beta_{ij} PE_i^* PE_j^* + e_i^* \right] \quad (4)$$

where $PE_i = PP_i / P^{\#}$ – the normalized price of the ith netput, PP_i is the producer price or input price, $P^{\#}$ is an arbitrarily chosen price as the numeraire, π^* is normalized profit, V_k^* is the kth conditioning (shifter) variable, e* are error terms.

The consumer core of the model describes fish consumption behaviour of households. It is flexible enough to accommodate household demands disaggregated by region and/or income class. Within each region/income class is a representative household that determines how much fish to consume.

The decision process of each representative household is specified as a three-stage budgeting framework premised on utility maximization (Dey, 2000). The first stage is represented by an equation that determines the demand for food as in equation 5. It assumes that food expenditures depend on the prices of food and non-food products, income and other socio-economic factors.

$$\ln fdex^* = \alpha_0 + \alpha_1 \ln pfd^* + \alpha_2 \ln pnfd^* + \beta_1 \ln y^* + \beta_2 (\ln y^*)^2 + \sum_i c_i Z_{1i}^* + \varepsilon^* \quad (5)$$

The second stage determines the representative household's demand for fish as a whole. It specifies fish expenditure as being dependent on aggregate fish prices, prices of non-fish food prices, real food expenditure and other socio-economic factors.

$$\ln fshex^* = \alpha_0 + \alpha_1 \ln pfsh^* + \sum_{i=2} \ln pfd_i^* + \beta_1 \ln fdex^* + \beta_2 (\ln fdec^*)^2 + \sum_i c_i z_{2i}^* + \varepsilon_i \quad (6)$$

The final stage captures the demands for the different types of fish. This is formulated as a Quadratic Almost Ideal Demand System (QUAIDS) in which the expenditure shares of the different types are expressed as a function of the consumer prices of fish types, real fish expenditure, and other socio-economic variables (Deaton and Muellbauer, 1980; Blundell, *et al.*, 1993).

$$s_i^* = \alpha_i + \alpha_{ij} \ln P_j^* + \beta_{i0} \ln(fshex^* / P^*) + \beta_{i1} (\ln fshex^* / P^*)^2 + \varepsilon_i \quad (7)$$

where fdex is food expenditure, Pfd is price of food, Pnfd is price of non-food, y is income, fshex is fish expenditure, Pfsh is price of fish, z_1 and z_2 are demand shifters, s is the expenditure share of fish type, P is fish price index, and the Stone approximation of the index is $\ln P^* = \sum_i s_i^* \ln P_i^*$.

The trade core of the model comprises a series of export supply and import demand equations.[1] It follows the tradition of Applied General Equilibrium (AGE) models that impose the Armington (1969) assumption, i.e., domestic and foreign goods (fish types) are treated as differentiated products. The import equations in the trade core are represented by Equations (8) and (9) while those for export are shown in Equations (10) and (11).

$$\ln\left(\frac{Qdh}{Qm}\right) = \alpha \ + \sigma \ln\left(\frac{nrp}{nwp}\right) \quad (8)$$

$$dpdc = \frac{Qdh}{Qdh + Qm} = \frac{1}{1 + wd^{\sigma}} \quad (9)$$

$$\ln\left(\frac{Qsh}{Qx}\right) = \alpha \ + \sigma \ln\left(\frac{nrp}{nwp}\right) \quad (10)$$

$$dcdp = \frac{Qsh}{Qsh + Qx} = \frac{1}{1 + wd^{\sigma}} \quad (11)$$

where Qdh is quantity of domestic production, Qm is quantity of imports, dpdc is domestic production in domestic consumption, nrp is net revenue per unit of domestic production, wd = (α_1 / α_0)(nrp / wp), wp is net revenue per unit of import, σ is elasticity of substitution, Qsh is quantity of domestic demand, Qx is quantity of export, and dcdp is domestic consumption in domestic production. The equations suggest that the export supply of a particular fish type is a function of its (i) price in foreign markets relative to domestic markets, and (ii) domestic output. On the other hand, the import demand for a particular fish type depends on (i) the price of imports relative to domestic goods, and (ii) domestic demand.

The model closure condition brings together demand and supply of fish to solve for equilibrium. In a multi-market setting, all markets must reach equilibrium simultaneously, with a specific set of prices. The equilibrium conditions are:

$$Qs_i - X_i = Qd_i - M_i$$

where Qs is domestic supply, Qd is domestic demand, X is export and M is import.

III. EMPIRICAL DIMENSIONS OF THE MODEL

The Malaysian fish supply and demand model needs substantial amount of data and the information required needs to be consistent, adhering to basic accounting identities deemed relevant to fisheries and any other commodity. In addition, the model needs parameters for its behavioral equations. These data and parameters need to be assembled from different sources and adjusted to ensure a consistent data set.

The Initial Value of the Model Endogenous Variables

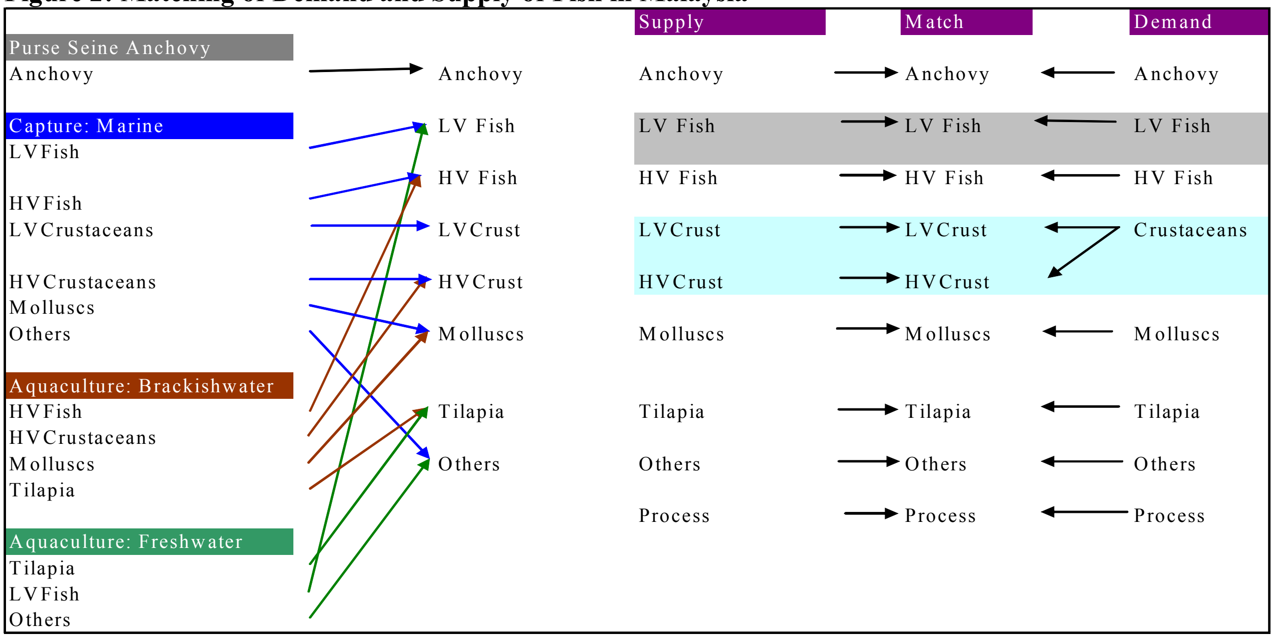
The data set that formed the initial values to drive the model was assembled for the year 2000. The choice of the year was determined primarily by the availability of detailed production and consumption data. In assembling the initial values, the objective was to organize the data and information into a balance sheet. Such a balance sheet clearly indicates the sources and destination of output.

In constructing the balance sheet, all fish species of commercial value as listed in the Annual Fisheries Statistics are aggregated into 7 and 8 fish types respectively in the domestic demand and supply sides of the model as shown in Figure 2. This is because to construct a balance sheet for each species will add complexity to the model and the output of each species is sometimes too small to warrant its explicit treatment.

Figure 2 shows that the domestic supply of fresh fish in Malaysia is derived from various sources namely, marine capture, brackishwater aquaculture and freshwater aquaculture. Brackishwater and freshwater aquaculture represent all types of fish farming (e.g., ponds, fish cages, tanks, rope, mudflat etc). Marine capture fishery involves harvest operations using vessels of various sizes and myriad gears. All major fish types supplied according to these sources include anchovy, low value fish, high value fish, low value crustacean, high value crustacean, molluscs, and others. Figure 2 also reflects that a particular fish type can be produced or raised from different sources. For example, high value crustaceans can be sourced from brackishwater aquaculture and capture fisheries.

The fact that fish can come from different sources introduces a modeling problem. It raises the question of whether a fish type from a particular source is perceived to be the same as its counterpart coming from another source. In the model, fish types from different sources are modeled as perfect substitutes. This means that consumers are indifferent between the supply sources of fresh fish species. Thus, the outputs from these sources can be added to form a fish type.

Figure 2: Matching of Demand and Supply of Fish in Malaysia



Source: Ishak, *et al.* , 2004.

Each balance sheet assumes that the total supply of each fish type (S), except for Anchovy is equal to imports (M) and the sum of outputs from Marine Capture Fisheries (Q_{mcap}), Brackishwater Aquaculture (Q_{AqB}) and Freshwater Aquaculture (Q_{AqF}). That is, $S = M + Q_{mcap} + Q_{AqB} + Q_{AqF}$. On the other hand, total demand (D) is the sum of exports (X), intermediate demand (ID), rural household demand (HD_R) and urban household demand (HD_U). In other words, $D = X + ID + HD_R + HD_U$. Thus, it must be the case that S = D or $M + Q_{mcap} + Q_{AqB} + Q_{AqF} = X + ID + HD_R + HD_U$.

The construction of the model initial values requires adjustments in the raw data for two reasons. First, there is no single source for all the data needed in the model. For example, consumption data was obtained from the Department of Statistics while production data was taken from the Department of Fisheries. Second, some of the raw data had to be transformed in order to suit the requirements of the model. For example, consumption data from the Department of Statistics is based on survey information. As this does not constitute information for the entire country, the approach adopted was to compute per capita consumption for each fish type. This was then multiplied with regional population data in order to compute regional and national consumption.

The basic principle in adjusting the data was to retain as much as possible the original values that are relatively reliable or are at least model consistent. In this regard, the absence of data on intermediate demand made it a logical avenue for making adjustments. Intermediate demand was calculated as a residual. That is, a value for this variable was chosen to ensure that *S* = *D*. In instances where the computed intermediate demands are negative, their values were set to zero and consumption adjusted to ensure that the balance sheet identity holds.

Table 1 shows a summary balance sheet for the different fresh fish types in the model. It identifies supply by source (Imports, Anchovy, Marine Capture, Brackishwater Aquaculture and Freshwater Aquaculture) and demand by destination (Exports, Rural Household Consumption, Urban Household Consumption, and Intermediate Demand).

Table 1: Balance Sheet for Fish Types in the Malaysian Model, 2000

Items	Anchovy	Low Value Fish	High Value Fish	Low Value Crustacean	High Value Crustacean	Molluscs	Tilapia	Others	Total
Quantity (thousand mt)									
Production									
Marine capture	22.52	713.47	342.53	61.86	47.86	97.47	0.00	30.2	1315.91
Brackishwater culture	0.00	0.00	7.73	0.00	16.12	75.7	0.19	0.00	99.74
Freshwater culture	0.00	19.06	0.00	0.00	0.00	0.00	18.28	0.00	37.34
Imports	18.04	255.06	6.21	12.42	8.92	8.22	0.00	4.5	313.37
Exports	3.13	49.73	5.12	5.51	30.11	29.321	0.00	9.33	132.251
Household demand	33.61	474.71	70.25	29.74		46.58	5.66	14.29	674.84
Intermediate demand	3.81	463.15	281.1	49.09	32.73	105.48	12.82	11.08	959.26
Balance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Value (million RM)									
Production									
Marine capture	0.45	23.66	30.90	2.88	7.64	5.18	0.00	2.06	72.76
Brackishwater culture	0.00	0.00	0.70	0.00	2.57	3.90	0.01	0.00	7.18
Freshwater culture	0.00	0.63	0.00	0.00	0.00	0.00	1.01	0.00	1.64
Imports	0.39	7.05	0.55	0.73	1.49	0.50	0.00	0.39	11.11
Exports	0.10	2.17	0.48	0.34	7.74	1.69	0.00	0.57	13.08
Household demand	0.72	22.81	7.63	4.94		3.78	0.38	1.81	42.08
Intermediate demand	0.01	6.36	13.97	0.73	1.56	4.10	0.64	0.08	27.45
Balance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Ishak, *et al.,* 2004.

The Parameters of the Model

The model requires parameter values for the behavioral equations of its producer, consumer and trade cores. This requirement was met through a combination of techniques. First, all relevant price and non-price elasticities on the supply side and the expenditure elasticities on the demand side were estimated econometrically using data from various sources. Second, for non-significant elasticities and those with wrong expected signs, adjustments were made based on the literature and consultation with the experts. Once obtained, these elasticities were transformed to suit the specification of the model equations. The intercept terms of all the relevant equations were then calibrated to ensure that the model replicates the initial values.

For the trade core, the relevant parameters needed were (a) elasticity of transformation between goods destined for domestic and foreign (exports) markets, and (b) elasticity of substitution between fish types sourced from domestic and foreign (imports) producers. Following the Applied General Equilibrium model of Cororaton (2000) no attempt was made to estimate these elasticities. The model assumes a value of 0.50 for these elasticities.

IV. SOLVING THE MODEL

Given its current level of disaggregation, the Malaysian fisheries supply and demand model had 256 equations. (Detailed specification of the model equations can be obtained from the authors.) This is relatively still quite small as many of the more comprehensive applied general equilibrium models easily have thousands of equations.

Using the values of the exogenous variables, the parameter values and with the actual values of the endogenous variables serving as initial values, the model was solved using the MINOS solver of the Generalized Algebraic Modeling System (GAMS) software. The base year for the model was 2000.

Once the model was calibrated, it was then used to make projections for the Malaysian fisheries sector to the year 2020. The projections provide an outlook of future trends in the demand, supply, price and trade in fish products.

Results of Projection to 2020

In making projections, assumptions were made regarding the future values of all the exogenous variables in the model. Table 2 shows the assumed historical growth rates of selected exogenous variables used in the projections. Those not shown were assumed to have no change in the growth rates.

Table 2: Growth Rates of Selected Exogenous Variables, 2000

Variable	Growth Rate [a]	Data Obtained From [b]
Population		
Rural	1.5	DOS
Urban	2.0	DOS
Prices		
Fish import	0.5	MITI
Fish export	0.8	MITI
Meat	1.50	FAMA
Cereals	1.50	FAMA
Fresh vegetables	1.50	FAMA
Beverage	1.50	FAMA
Other food	1.50	FAMA
Fishing effort	1.00	DOF
Fish feed	1.00	DOS
Non-fish food	3.08	DOS
Real per capita income		
Rural	3.29	IMF
Urban	3.29	IMF

Note: [a] All growth rates are in percentage per annum.
[b] DOS – Department of Statistics Malaysia, MITI – Ministry of International Trade and Industry Malaysia, FAMA – Federal Agriculture Marketing Authority of Malaysia, DOF – Department of Fisheries Malaysia and IMF – International Monetary Fund.

The results of the model projections to year 2020 are presented in the Tables below. The presentation begins by describing the aggregate results in order to provide an overall impact of the potential changes in the fisheries sector. It then proceeds by discussing the detailed results for output, consumption and trade designed to explain the aggregate results and to illustrate the potential changes in the structure of the fisheries sector. In order to minimize clutter in the text, the tables present the values of the variables for the base year (i.e., 2000) and the projected average annual growth rates from 2001 to 2020. "Year by year" solutions of the model are available from the authors on request.

Aggregate Results

On the whole, the model projects sluggish growth for fish output at an average annual rate of 1.53 percent (Table 3). In terms of the value of output, it is expected to grow at 5.92 percent per annum. The higher growth rate of the values suggests that prices of output as a whole are likely to increase by roughly 4.39 percent per annum over the projection period.

On the other hand, household fish consumption on average, as shown in Table 3 grows at a modest rate of 9.68 percent per annum. The large growth rate of household consumption is met by growth in fish imports at a rate of 15.76 percent per annum. The value of consumption, as shown in Table 3, is expected to grow at 18.08 percent, implying that prices of fish consumed are expected to rise moderately over time. In contrast, the value of import grows at a rate lower than the growth rate of imports, reflecting that import prices for fish and fisheries products are expected to decline in the future. Table 3 also shows the quantity and value of exports are projected to decline at –2.40 and –0.47 percent respectively during the projected period.

The preceding results suggest the following future scenarios for the Malaysian fisheries sector. First, import will be an important source of fish supply, given the sluggish expansion in domestic output. Second, household consumption and intermediate demand will continue to expand and, given the sluggish expansion in domestic output, will result in fish export to grow at a declining rate. Finally, the higher rate of imports coupled with declining rate of exports imply that Malaysia will be a net importer of fish over time.

Output Projections

The output and value of fresh fish as shown in Table 4 are expected to expand at 1.53 and 5.92 percent per annum, respectively. Expansion of output is mainly from brackishwater aquaculture at 5.42 percent per annum. However, output from the anchovy fishery is expected to decline by four percent over time. On the other hand, Table 4 shows that the values of fresh fish from all production systems are expected to expand, with both brackishwater and freshwater aquaculture registering growth rates of 6.96 and 6.65 percent annually. These changes are higher than the respective changes in the quantity of output implying that the average prices of fresh fish from these supply sources are likely to expand over time.

Table 3: Projections for Selected Fish Aggregates, 2001-2020

	Baseyear[a]		Projected Growth (percent p.a.)	
	Quantity	Value	Quantity	Value
Output	1435.5	9999.12	1.53	5.92
Imports	313.36	1110.7	15.76	15.49
Exports	132.24	1308.3	-2.40	-0.47
Consumption	665.12	2970.98	9.68	18.08
Intermediate demand	951.51	6830.54	1.56	5.74

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively.
Source: Ishak, *et al.*, 2004.

The projected output patterns across fish types are shown in Table 5. It shows that Tilapia (10.97 percent), Others (2.22 percent), Low Value Fish (1.62 percent) and Molluscs (1.27 percent) are the fish types that are expected to have the highest growth rates. In contrast, the outputs of Anchovy (-4.00 percent), High Value Crustacean (-0.52 percent) and Low Value Crustacean (-0.52 percent) will experience large declines.

Table 4: Projections for Fisheries Output by Source, 2001-2020

	Baseyear[a]		Projected Growth (percent p.a.)	
	Quantity	Value	Quantity	Value
Total output	1435.5	9999.12	1.53	5.92
Fresh fish by source				
Marine capture	1275.91	8846.97	1.17	5.82
Anchovy	22.52	60.45	-4.00	5.66
Brackishwater aquaculture	99.74	926.55	5.42	6.96
Freshwater aquaculture	37.33	165.15	0.60	6.65

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively.
Source: Ishak, *et al.*, 2004.

The patterns of change cited above provide insights into the potential structure of the fisheries sector by 2020. It suggests that the three fastest growing fish types will have a larger share of the total output of fresh fish and will be the major sources of growth for the sector. The change in fish outputs also indicates that Brackishwater and Freshwater Aquaculture are likely to be the sources of growth for fisheries in the future. This can be seen from the results as Tilapia, Molluscs and, to some extent, Low Value Fish are produced in these sub-sectors. It is also worth noting that Anchovy and Low Value Crustacean are produced in the Marine Capture sub-sector. The contracted growth rates for the latter indicate that the natural stocks for these fish types have been overexploited. On the other hand, High Value Crustacean is produced by the Marine Capture and Brackishwater Aquaculture sub-sectors but the present contribution of the latter is relatively small.

Table 5 shows that the producer price of all fish types except High Value Fish are increasing, with Anchovy price registering the highest growth, followed by Low Value Fish, Others, Molluscs, and Tilapia. Fish types with high average producer price (High Value Fish, High Value Crustacean and Low Value Crustacean) have the slowest (or negative) increase in producer price. These results indicate that producer price changes may not offer adequate explanations for changes in outputs. Other factors such as shifts in consumption patterns among fish types may also be important.

Table 5: Projections for Fisheries Output by Fish Types, 2001-2020

	Baseyear[a]		Projected Growth (percent p.a.)	
	Quantity	Producer Price	Quantity	Producer Price
Total output	1435.5	nc	1.53	nc
By fish type				
Anchovy	22.52	2.60	-4.00	10.64
Low value fish	732.52	3.32	1.62	8.96
High value fish	350.26	12.02	0.94	-0.06
Low value crustaceans	61.86	7.65	-0.02	0.59
High value crustaceans	63.98	26.96	-0.52	0.87
Molluscs	173.17	5.31	1.27	6.76
Tilapia	18.47	5.50	10.97	2.82
Others	12.73	5.16	2.22	7.39

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively. nc – not computed.

Source: Ishak, *et al.*, 2004.

Demand Projections

The projected average annual growth rates in the consumption of different fish types and regions as shown in Table 6 may explain the observed patterns for consumption changes across fish types and regions. Table 6 indicates that the consumption of all fish types is expected to expand. A significant result here is the relatively rapid increase in the consumption of Low Value Fish (10.66 percent per annum), Tilapia (10.97 percent per annum) and Others (21.66 percent per annum). As the Low Value Fish accounts for a relatively large share of total consumption, this fish type therefore explains the expected pattern in the aggregate. Table 6 also shows the consumption of High Value Fish and Crustacean have the slowest growth, possibly due to their relatively high retail prices.

Table 6: Projections for Fish Consumption by Fish Type and Region, 2001-2020

	Baseyear[a]		Projected Growth (percent p.a.)	
	Quantity	Consumer Price	Quantity	Consumer Price
Total quantity	665.12	nc	9.68	nc
By fish type				
Anchovy	33.61	2.36	6.02	4.14
Low value fish	474.71	3.02	10.66	3.73
High value fish	70.25	11.75	0.82	-0.02
Crustaceans	29.74	10.37	0.03	0.54
Molluscs	46.58	5.45	5.34	5.07
Tilapia	5.66	5.50	10.97	2.82
Others	4.57	8.67	21.66	0.54
By region				
Rural	270.16	nc	14.48	nc
Urban	394.95	nc	-2.45	nc

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively. nc – not computed.

Source: Ishak, *et al.*, 2004.

The results also indicate different projected trends across regions. The total consumption of fish in the rural sector is expected to expand by an average annual rate of 14.48 percent. In contrast, the consumption of fish by the urban sector is expected to contract by an average annual rate of 2.45 percent. It should be noted that the consumption figures represent only fish consumption at home and do not include fish consumption away from home. As the population and income of urban households increase, fish consumption tend to switch from home to away from home.

The projected pattern of changes for per capita fish consumption of the different regions is shown in Table 7. In the case of the rural sector, the projected per capita fish consumption is not too difficult to see because the decline occurs for higher priced fish types (High Value Fish and Crustacean). On the other hand, the pattern for urban households indicates the decline in the consumption of all fish types except High Value Fish (0.56 percent) and Others (2.07 percent).

Table 7: Projections of per Capita Fish Consumption by Fish Type and Sector, 2001-2020

	Baseyear[a]		Projected Growth (percent p.a.)	
	Rural	Urban	Rural	Urban
Quantity				
Anchovy	1.58	1.36	8.72	-5.45
Low value fish	22.66	19.01	13.77	-6.64
High value fish	2.47	3.36	-7.78	0.56
Crustaceans	1.12	1.38	-5.96	-0.27
Molluscs	2.18	1.89	8.04	-6.21
Tilapia	0.32	0.20	13.11	-3.47
Others	0.22	0.18	25.47	2.07
Consumer price				
Anchovy	2.15	2.15	4.14	4.14
Low value fish	5.75	5.84	3.73	3.73
High value fish	10.76	10.91	-0.02	-0.02
Crustaceans	16.14	16.86	0.54	0.54
Molluscs	7.92	8.26	5.07	5.07
Tilapia	6.65	6.67	2.82	2.82
Others	12.4	12.85	0.54	0.54
Fish expenditure	409.13	407.47	15.67	-1.34
Price index (stone)	1.95	2.03	1.84	0.99
Real fish expenditure[b]	nc	nc	13.38	-2.33

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand metric tons and millions Ringgit, respectively. [b] The change in real fish expenditure is approximated by the difference between the changes in fish expenditure and the price index. nc – not computed.

Source: Ishak, *et al.*, 2004.

To explain the responses of the individual fish types, it is useful to note that the demand side of the model uses a Quadratic Almost Ideal Demand System (QUAIDS) formulation (see Ishak, *et al.*, 2004). Ignoring the details, it states that the demand for a particular fish type depends on its own price, prices of related goods and real fish expenditure. In the case of the rural households, increase in per capita fish consumption across the board is due to the overwhelming increase in the real fish expenditure, even though own-prices of most fish types increase as well. The substitutions by other fish types (positive cross prices) probably explain the decreasing rate of per capita consumption for High Value Fish (-7.78 percent). In the case of Crustacean, the declining rate of per capita rural consumption (-5.96 percent) is due to the greater impact of own price rather than the expenditure effect. The analysis for the urban households is the reverse. Increases in the own-prices coupled with the decline in the real fish expenditure caused the per capita consumption for most fish types to decline. Again, for High Value Fish, the per capita urban consumption shows an increasing rate due to the impact of the declining retail prices.

Trade Projections

It was noted earlier that imports and exports are projected to move in opposite directions. While the quantity of exports is expected to decrease, the quantity of imports is expected to increase. The succeeding paragraphs present the details explaining this pattern as well as the future trend in fish trade.

Table 8 provides information on the expected increase in total imports. It shows that Anchovy (12.22 percent per annum), Low Value Fish (16.40 percent per annum), Molluscs (13.12 percent per annum) and Others (21.74 percent per annum) are expected to experience large increases in imports. In the model, changes in total demand and relative prices affect the imports of a particular good. Higher total demand tends to raise the demand for imports. On the other hand, a decline in the relative price of imports (import price / composite price) tends to increase import demand. The values in Table 8 suggest that changes in relative price are sufficient to explain the pattern of changes for the quantity of fish imports. The increase in the demand for imports of fish types, mentioned in the preceding paragraph, is primarily due to the decline in the relative price of imports.

Table 8: Projections for Imports by Fish Type, 2001-2020

	Baseyear[a]	Projected Growth (percent p.a.)		
	Quantity	Quantity	Import Price	Composite Price
Total	313.36	15.76	nc	nc
By fish type				
Anchovy	18.04	12.22	0.50	4.14
Low value fish	255.06	16.40	0.50	3.73
High value fish	6.21	0.06	0.50	-0.02
High value crustaceans	12.42	0.24	0.50	0.51
Low value crustaceans	8.92	0.15	0.50	0.56
Molluscs	8.212	13.12	0.50	5.07
Tilapia	na	na	na	2.82
Others	4.50	21.74	0.50	0.54

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively. nc – not computed and na – not applicable.

Source: Ishak, *et al.*, 2004.

Table 9 presents the breakdown for projected exports. It shows that, with the exceptions of High Value Fish (1.86 percent per annum), High Value Crustacean (0.25 percent per annum) and Others (2.01 percent per annum), the exports of specific fish types are expected to decline over the projected period. It also indicates that Anchovy (12.44 percent per annum), Low Value Fish (6.10 percent per annum) and Molluscs (3.59 percent per annum) exports are likely to decline rapidly. However, the decline in Anchovy exports offers very little in explaining the aggregate exports because of its relatively small share in total exports. The major contributors in this case are Low Value Fish and Molluscs.

As with imports, changes in relative price explain most of the trends in the exports of fish types. The decrease in exports may be explained by the decrease in the relative price of exports for Anchovy, Low Value Fish and Molluscs. In addition, greater domestic demand for these fish types, in particular in the rural sector tends to reduce export as outputs for these fish types need to satisfy domestic demand.

Table 9: Projections for Exports by Fish Type, 2001-2020

	Baseyear[a]	Projected Growth (percent p.a.)		
	Quantity	Quantity	Export Price	Composite Price
Total	132.24	-2.40	nc	nc
By fish type				
Anchovy	3.1298	-12.44	0.80	10.08
Low value fish	49.73	-6.10	0.80	8.31
High value fish	5.12	1.86	0.80	0.00
High value crustaceans	5.51	0.25	0.80	0.65
Low value crustaceans	30.11	-0.53	0.80	0.80
Molluscs	29.32	-3.59	0.80	5.42
Tilapia	na	na	na	2.82
Others	9.33	2.01	0.80	0.99

Notes: [a] The baseyear values are for year 2000. Quantities and values are expressed in thousand mt and million RM, respectively. nc – not computed and na – not applicable.

Source: Ishak, *et al.*, 2004.

V. SUMMARY AND CONCLUSIONS

This paper attempts to discern the patterns of changes by making projections of the Malaysian fish supply and demand given that the existing conditions in the fishery sector and the economy as a whole persist in the future. These supply and demand changes in the fishery sector have important implications to the achievement of the objectives of food security, poverty alleviation and food trade balance expounded by the Malaysian Government in the Third National Agriculture Policy.

The construction of the supply and demand model for the Malaysian fisheries is described in the paper. The model is fairly detailed and includes the producer, consumer, trade cores as well as the model closure equation. It allows the analyses on sources of fish supply, fish types, regional demands, trade, and so on.

By making assumptions with regard to the future values of all exogenous variables in the model, the results from the projections suggest the following trends of supply, demand, prices and trade for the Malaysian fisheries sector in the future:

1. Output increases sluggishly but the rate of increase in output prices is higher thereby enhancing output value over time. Future output growth is likely to originate from brackishwater aquaculture since natural fish stocks, in particular those for anchovy and low value fish, have been over-exploited. Tilapia, Low Value Fish, Molluscs and Others show the greatest potential for future contribution to output growth.
2. Future fish consumption is projected to increase due to rising population and household income. Rural per capita consumption is expected to increase but urban household per capita fish consumption is projected to decline because as income increases, urban households consumption of fish switches from home to away-from-home. Major fish types consumed by rural households consist of Tilapia, Low Value Fish and Others and the consumption of these fish types is projected to increase. On the other hand, the per capita consumption of High Value Fish by rural households is projected to decline as prices of this fish type increases. Per capita consumption of High Value Fish, however, is projected to increase for urban households.
3. Increase in rural consumption of fish coupled with sluggish expansion of domestic output will result in increases in imports. The main fish types imported consists of Anchovy, Low Value Fish, Molluscs and others.
4. Aggregate fish exports are projected to decline in the future as output increases will be insufficient to cater for the increase in household fish consumption. However, the exports of selected fish types such as High Value Fish, High Value Crustacean and Others that are not consumed by rural households in large quantities, are projected to increase.
5. High rate of import coupled with declining rate of export imply that Malaysia will be a net importer of fish over time.

The results above appear to imply that the Malaysian fishery sector may not be able to make significant contributions to the objectives of raising fish producers' income, increasing household consumption of fish or protein intake and reducing the deficit food trade balance if the sector's current situation persists in the future. Efforts need to be stepped up in order to increase fish production, reducing fish prices and increasing net value of fish trade. These may be achieved through the following strategies:

1. Technological improvement in freshwater and brackishwater aquaculture,
2. Expanding freshwater and aquaculture production areas,
3. Improvement in fish marketing efficiency for both the domestic and export markets,
4. Reduction in the cost of inputs used in aquaculture, in particular for feed and seeds,
5. Reducing fishing effort in the inshore marine areas, and
6. Enhancing natural fish stocks in the marine waters.

However, it must be stressed that since the potential impacts of the strategies suggested above may take a long time to be realized, these impacts need to be evaluated first before they are implemented.

NOTE

1. The need for explicit export demand and import supply equations is eliminated by the assumption that each country is a small open economy.

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