Potential Welfare Effects of Soy-Based Mariculture Feed

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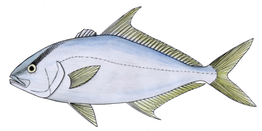


Introduction

- Global aquaculture production doubled between 2000 and 2012, while production of compounded aquaculture feed from the feed industry increased about five fold.
- Rapid growth of aquaculture is challenging the sustainability of the fisheries that provide fishmeal and fish oil.
- The inclusion of soybean products such as high Omega-3 soybean oil (STA oil) and soy protein concentrate (SPC) into the mariculture diet may reduce this pressure.
- The inclusion of STA oil in the diet of *S. rivoliana* (a diet with high Omega-3 soyoil substituting 50% of fish oil) is technically feasible (Eckert, *et al*. 2006).
- Bairagi *et al*. (2014) found that about 1% of total cost reduction is possible with the STA oil diet vs traditional diets.

Objectives

- To examine the market and welfare impacts of the adoption of STA oil mariculture diets on U.S. as well as Peruvian markets.

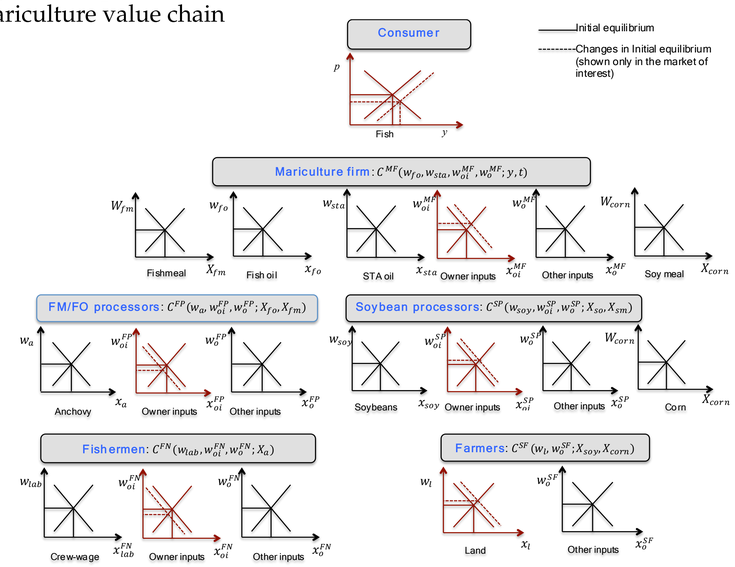
Methods

A comparative statics approach elaborated by Perrin (1997) is used.

- Initial equilibrium conditions:
  a. Demand for output: $y = f(x)$
  b. Optimal outputs: $\frac{dc(w;y,t)}{dy} = p$, zero-profit condition
  c. Optimal inputs: $\frac{dc(w;y,t)}{dw} = x$, Shephard lemma
  d. Supply of inputs: $x = g(w)$
- Log-linearized forms of a-d equations are:
  a′. $dlny - \eta dlnp = 0$
  b′. $dlnp - (\varphi_i' + \theta\iota')\mathbf{K}dlnw - \mu dlny = -(\delta + \sigma)dt$
  c′. $dlnx - \mathbf{H}dlnw - (\varphi + \theta\iota)dlny = (\beta_i - \delta\iota)dt$
  d′. $dlnx - Sdlnw = 0$
- Leontief cost function: $C = y\sum_{1=1}^{N} \alpha_i w_i$
  c″. $dlnx_i - dlny = dln\alpha_i$

Equilibrium Displacement

Figure 1. Impact of STA oil ration on different stakeholders in the mariculture value chain



Results

Table 2. Distribution of economic surplus (millions of 2013 $)

Beneficiaries	Welfare gain/loss (if the STA oil diet is used for production of:)			
	All yellowtail		All yellowtail and all farmed salmon	
	% of product value	Value ($ million)	% of product value	Value ($ million)
Total benefits		419		2,724
Consumers surpluses	0.25	9	0.31	44
Mariculture firms	2.22	27	2.77	127
U.S. Soybean processors	7.81	286	52.46	1,923
U.S. Soybean farmers	0.82	100	5.41	659
Peruvian Fishmeal\Fish oil processors	-0.27	-3	-2.33	-27
Peruvian anchovy fishermen	-0.13	-0.3	-1.10	-3

Results

Table 1. Changes in initial equilibrium price and quantity due to the adoption of STA diets

	If the STA oil diet is used for production of:			
	All yellowtail		All yellowtail and all farmed salmon	
	% Change in quantity	% Change in price	% Change in quantity	% Change in price
Mariculture production	0.22	-0.25	0.28	-0.31
STA oil	765.2	9.8	765.2	64.6
Soybean oil	1.37	-6.8	8.99	-44.7
Soybean meal	0.5	-3.3	3.6	-21.9
Soybeans	0.9	0.7	0.8	4.7
Corn	0.1	-0.3	0.5	-2.1
Fish oil	-0.1	-1.09	-0.8	-9.3
Fishmeal	-0.01	0.02	-0.1	0.2
Anchovy production	-0.03	-0.02	-0.2	-1.4
Owners' own inputs				
Mariculture firms	0.2	2.2	0.3	2.8
Soybean processors	0.8	7.8	5.1	51.2
Soybean farmer (land)	0.02	0.8	0.1	5.4
Fishmeal/fish oil processors	-0.03	-0.3	-0.2	-2.3
Anchovy fishermen	-0.01	-0.1	-0.1	-1.1

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Conclusions

- U.S. soybean processors would benefit the most, followed by soybean farmers, and mariculture firms.
- Consumer surplus would increase.
- However, Peruvian fishmeal/fish oil processors and fishermen would lose.
- While the estimated 1% cost savings of the new technology is small, adoption is likely because of the improved sustainability, and the impacts on the various stakeholders can be substantial.

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