ENSO, Regime Shifts, The Peruvian Anchovetta Catch and Fisheries Management: Some Preliminary Observations[1]

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"In 1864 The Norwegian government asked George Ossian Sars...to determine why the cod catches from the Lofoten Islands in Northern Norway fluctuated so greatly."[2]

I Linkages

Variation in supply [stock size] is a central problem in determining the optimal organization of the fishing industry and in how governments can best regulate fishing effort. Two developments: investigation of the relationship between climate and the size of small Pelagic fishstocks,[3] and the extension of this relationship to include its impact on economic activity indicate the importance of specifying the linkage among changes in the environment, a profitable and stable industry and conservation of the resource base.[4]

Here we examine one case, the catch of Anchovetta by Peru over the 40 year period from 1960 to 1999 where the reported catch (supply) ranges from a high of 12.3 million metric tons to a low of 23 thousand metric tons. At its high points, in physical volume, this is the worlds largest fishery. The output, fish meal, is an important element in the world market for animal feed and therefore it resembles other commodities such as soy beans, etc. Fish meal output, worldwide, varies around 6.5 million metric tons of which 4 mmt are involved in world trade.

II Measurement

The estimation of relationships between stock size and its environment (climate) presents a number of difficulties. The first is conceptual. While the physical/biological literature is clear about the existence of the Enso phenomena, (chart 1) and biological regime shifts neither is defined as to duration and amplitude. Of greater importance is that neither event is precisely defined so that the inception of its impact on a stock of fish can be identified, i.e. neither a yield function nor production function can be identified. Further the catch data are annual so that annual values of the Enso index (sea surface temperature, a proxy for Enso) must be employed. The principal management instrument used by Peru is a system of closing the fishery during a year (the veda).

Direct attempts to correlate catch and temperature using various lead times produced inadequate results. However, when the temperature data was considered as having two components both el nino events and regime shifts then meaningful results were obtained. These results are similar to those obtained by Cane et al in linking the Enso index with maize yields in Zimbabwe. It is up to the climatologists and marine biologists to provide the theoretical structure that will lead to understanding of the component elements reflected in the index, how they interact and in what ways they impact the stock of fish.

In any case the important economic impact on the industry results from the large variation in supply. If we assume the large swings in supply result from some combination of the Enso phenomena and regime shifts and we use a dummy variable to delineate regime shifts then we may measure the link between changes in the Enso index and catch. The catch data, chart 2, suggest three regimes over this time period one from the inception of the large scale commercial fishery in the late 1950's - early 1960's , one from the collapse in the early 70's until the next regime, the remarkable increase in catch in the 1990's. The period 1996-99 is of particular interest as it may indicate the impact of the strong El nino on that regime.

These results indicate the importance of incorporating environmental change in existing models used by fishery managers, i.e., that while overfishing remains a key concern of regulators it is not, at least in this case, a sufficient condition to explain stock variability. In the case of Peru it raises questions about the utility of the existing management instrument, which by closing the fishery attempts to move the catch forward in time.

Finally the mix of several kinds of environmental forces combined with and the economics of the utilization of a valuable common property resource provide a stark glimpse of the complex reality of the supply side of the fisheries management problem.[5]

III. The Economics

Fish meal, the end product of this fishery is a small but important component in the preparation of animal feed, primarily for chickens, pigs and aquaculture. Price is determined in the world market (F.O.B. Hamburg) as it is for other large components of animal feed such as soy meal etc. Given the size and growth in the market for animal feed and the relative small output of fish meal. The industry in Peru tends to be profitable because feed producers need the valuable protein contained in fish meal.

In the early 1970's the collapse of the stock resulted in wide spread failure of firms in the industry and the creation of Pesca Peru a government agency. Pesca Peru took over the industry until the early 1990's when it was returned to the private sector, only to experience losses during the 1996-7 event. These boom-bust results stem from a combination of supply variations and firms that are weak financially, i.e. financed by bank loans, current liabilities rather than equity. As in all market based economic activity commercial fisheries are beset by both supply side and demand side problems. The demand side difficulties are not atypical of those faced by many other small businesses, prices are apt to be volatile and there may be sudden changes in tastes for the output.

The Peruvian case provides an exaggerated view of the difficulties presented to the industry by variability in supply. The widespread recognition of the impact of El Nino combined with the less well known regime shifts leaves firms and the government without a clear view of the determinants of supply. In these circumstances the creation of a stable prosperous industry structure must rest on a different concept of industrial organization.

The addition of climate as an element in the management of commercial fisheries suggests several lines of inquiry that are necessary to the understanding of the current state of commercial fisheries.

1) what determines regime shifts and how do they impact on the stocks of small Pelagics?

2) what are the linkages between small Pelagics and the predators at the top of the food chain, e.g., Caplin and Cod?

3) given wide and uncertain changes in supply what is the optimal economic organization of the industry, e.g. a small core industry that will always be profitable with a fringe of risk takers available to harvest any surplus?

Finally, note that there is an important worldwide income distribution problem involved in using Anchovetta and other small Pelagics for fish meal. Feeding the fish meal to chickens, pigs and Salmon rather than improving the product so that it can be directly consumed by humans is wasteful, (given the conversion factors involved) and it diverts the valuable protein to a high priced market rather than using it as a food supplement in a world with insufficient protein for much of the population.

Footnotes

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[2]Scaling Fisheries Tim P. Smith Cambridge University Press 1994, page 1.

[3] Empirical investigation on the relationship between climate and small Pelagic global regimes and El Nino - Southern occilation (Enso), F.A.O. Fisheries circular No. 934 D.B. Lluch-Cota, S. Hernandez Vazquez & S.E. Lluch-Cota Rome, November 1997.

[4]Forecasting Zimbabwean Maize yields using Eastern equatorial pacific Sea surface temperature. M. Cane, G. Eshel, & R.W. Buckland, Nature, vol. 370, 21, July 1994.

[5]Lluch-Cota op. cit; also A. Bakum “A Focus on Small Pelagic Fisheries” F.A.O. Documents; A. Bakum, “New Concept for Understanding Variability in Small Pelagic Fisheries”, F.A.O. Casablanca 1996; J.H. Steele, “Regime Shifts in Marine Ecosystems” Ecological Applications, September 1998.

[6]See also Colin Clark “Fishery Systems Are Much Too Complex, Biologically, Socially and Economically, for there to exist any simple solution to the problem of fisheries management.” “Bioeconomic Modelling and Fisheries Management”, 1991, John Wiley & Sons, Inc. P.10.

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