Economic Analysis of Factors Affecting Prices and Costs in the California Sea Urchin Fishery

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Master's Thesis[1]
by
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SUMMARY OF RESULTS

Introduction

California's sea urchin fishery is currently the most valuable fishery in the state. The majority of the sea urchin harvested off the California coast is shipped to large seafood markets in Japan, where sea urchin roe, known as *uni*, is a delicacy. This fishery has grown rapidly since its inception in 1968, peaking in 1989 when the annual harvest level approached fifty-two million pounds. However, in the past five years, the industry has experienced a decline in annual landings, and there are indications that sea urchin abundance is declining.

In an attempt to sustain the sea urchin stock, the California Department of Fish and Game has imposed restrictions upon the fishery, including seasonal closures, limited entry, and size limits. Recent modifications to the regulations indicate that the basic management structure will remain essentially the same in upcoming years, but will be more restrictive. Current management decisions are based primarily on biological information with secondary consideration given to the economic aspects of the fishery. Unfortunately, knowledge of both the biological and economic factors of this fishery lags behind what is needed for optimal fishery management.

Fishery managers need a better understanding of the economic forces that drive the industry. This information could help improve the effectiveness of management and could potentially generate larger benefits from this fishery. Prior to this study, no research has examined the effects that fishery regulations have had on the industry's profitability. In a regulated fishery, economic forces are important since they dictate the basic incentives which drive the industry. Such incentives include the amount of effort that is expended, how much is caught, and when the season is open. All of these incentives are impacted by fishery regulations. Since regulations generally reflect a balance between biological and economic factors, any regulations which severely affect industry profitability have less chance of being adopted.

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Understanding the economic aspects of the sea urchin fishery requires an understanding of both the cost structure of the industry and the market for *uni*. This study examined both of these components through the use of published data and data gathered from a survey conducted in August 1993. The goals of this research were to identify factors that affect both the supply and demand for California sea urchin products, and to provide an economic model of the fishery.

In this report, the results of the thesis are summarized and discussed. For a more complete understanding of the sea urchin industry in California, please see the unabridged version of the thesis, which begins with a review of literature published on sea urchin biology, the Japanese market, the history of the California fishery, and fishery management (Chapter II). The remainder of the thesis builds upon an understanding of each of these aspects of the sea urchin industry. In Chapter III, factors that affect the supply of California *uni* are identified, and the costs associated with supply are discussed. This qualitative information was obtained primarily from interviews with sea urchin processors. These interviews focused on processing procedure, urchin quality, costs associated with processing and shipping, and the market for urchin products.

Factors that influence consumer demand for *uni* are discussed in Chapter IV. Information from processor interviews and from published market data is used to identify the primary factors that influence consumer demand. A brief description of marketable urchin products follows a discussion of the primary markets for California sea urchin. The various factors that influence consumer demand are then identified and described. These factors include product price, quality, the availability of substitute products, and consumer income.

In Chapter V, two economic models are discussed. The first examines factors affecting consumer demand for *uni* imported into Japan, whereas the second examines consumer demand for Japanese domestic *uni*. These models test hypotheses regarding factors that influence the demand for both of these products. By utilizing these models in Chapter VI, the optimal harvest levels for the California sea urchin industry can be estimated. Finally, these results and their implications for the California sea urchin industry are discussed in Chapter VII.

Summary of results

This research identified and quantified factors that influence the supply and demand for California *uni* in the Japanese market. The primary factors that influence supply are the abundance of sea urchins, the ability of divers to harvest urchins, and the costs of production. Based on biological research of urchin abundance, the California Department of Fish and Game has imposed a variety of regulations on the sea urchin fishery in an attempt to maintain

urchin populations in California. Fishery regulations, combined with weather conditions, are the primary factors that influence urchin divers' ability to harvest urchins.

The total costs of producing *uni* for the Japanese market are high due to labor intensive harvesting and processing. In 1993, the average total costs of producing one pound of sea urchin roe in California and shipping it to Japan was over twelve dollars. The largest expense is purchasing whole urchin from the divers which, on average, accounts for over sixty percent of total costs. Processing costs account for just over ten percent of total costs. These costs include: overhead costs, labor costs, supplies, hoist operator fee, and transportation. Shipping costs to Japan account for approximately six percent of total costs. Additional costs in Japan include an import tax, the customs broker fee, transportation costs, and sales commission. After all these costs are paid, the remainder is the profit (or loss) for processors.

The primary factors that influence the demand for California *uni* in the Japanese market are its own price, quality, seasonal consumption patterns, consumer income, and prices of close substitute products. This research utilized monthly data from the Tokyo Central Wholesale Market in order to quantify the manner in which these factors influence *uni* prices. The findings confirm basic economic intuition; namely that as quantities of imported *uni* increase, the market clearing price in Japan must decrease. In addition, it was found that the Japanese demand for imported *uni* responds to the level of consumer incomes in Japan, and that it also depends upon the price of the closest substitute product, which is *uni* that is produced domestically in Japan.

Some attempt was made to quantify these relationships between Japanese demand and its determinants. It was found that *uni* demand is generally elastic over the season as a whole. This means that although an increase in the quantities marketed will decrease price, the price will not fall enough to reduce total revenues accruing to California marketers and harvesters. In particular, a ten percent increase in quantity marketed will reduce price by about eight percent. It was also found that for every one percent increase in Japanese consumer income, demand for imported *uni* rises about five percent. The size of this effect is suspiciously large and possibly spuriously associated with the coincident buildup of the Japanese *uni* market for imported products during a period of economic expansion. The impact of the price of domestically produced *uni* is also important to the price of imported *uni*. It was found, for example, that a one percent rise in the price of domestic *uni* will produce a half-percent rise in the quantity demanded of imported *uni*. Thus, the interrelationship between when California *uni* is marketed and when Japanese *uni* is marketed is of significant importance.

To further explore issues related to the interaction between these two markets, this thesis examined the pattern of demand and prices for both imported and domestic *uni* over the yearly marketing period. Results suggested opposing cycles in that when the demand for domestically produced *uni* is high in Japan (during July and August) the price of imported *uni* from California is relatively low. Conversely, when the demand for domestically produced *uni* drops off in the winter (October through February), the demand for imported *uni* picks up. This pattern deserves further investigation because it is unclear whether it is reflecting historical patterns of consumption in Japan, patterns of supply in both places, or changes in quality of *uni* in the market.

After quantifying fundamental market forces in Japan, an attempt was made to assess whether the California industry is being managed in a manner that best reflects market opportunities. The California industry is managed with two goals in mind; namely attempting to avoid biological overharvesting by regulating season openings and minimizing the impacts of closures on the economic health of the industry. Since closures take place mostly during the summer when prices are low, there is some reason to believe that conflicts between the two goals may not be severe. To quantify this issue, this thesis asked the question: given what was learned about the Japanese market, could California producers do much better overall by reallocating total yearly supplies to take advantage of the known patterns of Japanese demand for its product? The method used was as follows. First, the estimated statistical relationship between the two markets and their determinants were used to forecast how revenues for imported *uni* might vary over the season as the relative supply of imported *uni* varied, holding constant the pattern of Japanese supply. Then, an optimization routine selected the pattern of supply of imported *uni* that would maximize yearly revenues. Thus, this procedure acts as if a central marketing agency exists for all suppliers of imported *uni* and the agency chooses the pattern of supply (and implicitly harvesting) to produce the maximum revenues.

The findings from this exercise were interesting. First it was found that existing patterns of supply are not significantly different from what might have been done if centrally planned over the 1986-1991 period. Optimal revenues were always larger than actual, but the average yearly differences were only as high as 4.33 percent (in 1988) and averaged closer to 1-2 percent. Second, there was a consistent seasonal pattern in the divergence between actual and optimal revenues. In particular, in most years examined, revenues for the California industry could have been increased (slightly) by reallocating to late spring and summer markets and away from winter markets. For example, over the period simulated, November revenues were about ten percent lower than they might have been if supply had been reduced then and reallocated to spring and summer.

Implications for the California sea urchin industry

The overall goal of this research was to examine the tradeoffs between biologically motivated management of the California sea urchin fishery and industry profitability. The current fishery management strategy does take into account market conditions at a very general level. As discussed in the thesis, fishery closure days coincide with periods of poor roe quality and poor market conditions. However, results from this research show that it is possible to incorporate market conditions more precisely into the management strategy for the fishery. Industry profitability can be increased slightly through a reallocation of supply throughout the year, with no net increase in annual harvest level by restricting harvest levels in the winter and increasing them in the summer. By modifying fishery regulations slightly to reflect market conditions, fishery managers can increase the profitability of the industry without increasing total harvest levels. Furthermore, if total harvest levels continue to decline, then this model suggests that the optimal time to restrict effort is when demand is inelastic (i.e., in the winter months).

A major limitation to the application of these results is that they assume that the sea urchin industry in California can act as a single unit. This is obviously not the case. In fact, processors compete for the supply of whole urchin from divers, and divers compete for prime harvest locations. Further regulations may intensify competition within the industry, which in turn may increase costs. As a result, individual and industry profits may be reduced.

The applicability of these results is also limited due to the assumption that all other sea urchin fisheries that supply urchin to the Japanese market will not change their behavior as a result of the changes in the California industry. Further research is necessary to determine the elasticity of supply to the Japanese market from fisheries other than California's.

Recommendations for future studies

A substantial amount of additional research is necessary before the sea urchin industry and its market in Japan can be fully understood. Additional research is needed to determine the elasticity of supply for both the California fishery as well as other fisheries that supply sea urchin to the Japanese market. The results presented here are based on averages and broad generalizations. Since a considerable amount of variability exists in this fishery, more research is needed to determine if these generalizations are meaningful for this industry.

Finally, this study has explored primarily the economic aspects of the sea urchin industry. Even so, it is obvious that biological factors play a major role in determining the availability, quality, and ultimately, the demand for

this product. Although these biological factors were acknowledged in this study, they must be more fully integrated into management decisions.

On the simplest level, actual biological data can be incorporated into the optimization equation presented in Chapter VI. The biologically optimal harvest level for the fishery should be determined, and those levels should be used as the constraints of the model. In other words, the model can be used to predict future harvest levels through the use of actual market data and biological constraints. It is the intention of the author to continue this research of the sea urchin fishery, including the creation of a bioeconomic model (incorporating both biological and economic factors) of the industry.