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Capacity Measurement in Fisheries: What Can we Learn?

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Introduction

Since the Food and Agriculture Organization of the United Nations (FAO) report on fishing capacity, there has virtually been an explosion of researchers' interest in capacity measurement in fisheries (FAO 1998). This interest follows directly from the seminal work of Gordon (1954), who predicted that in a poorly managed fishery one will observe rent dissipation and a level of effort which is too high. This excessive effort presents itself as overcapacity in the form of too many vessels and excessive input factor use. This is also why the main focus in traditional command-and-control fisheries management has been the control of input factor use, such as restricted access and limitations on gear type, vessel size, and other inputs. In the recent general economics literature, there have been substantial developments in economic theory and methods to measure capacity utilization in a variety of industries. Given the focus on overcapacity in fisheries management, it is only natural that this has fueled the interest of fisheries economists to employ these tools.

There is little doubt that measurement of capacity utilization in a fishery can provide useful information with respect to similar issues as in other industries. Moreover, in many ways a measure of capacity utilization can be regarded as an index of how well a fisheries' management system works. In addition, the fact that poorly managed fisheries generate substantial redundant capacity due to rent seeking from the fishermen makes capacity measurement potentially an even more interesting management issue as indicated by Gordon (1954), particularly at the fleet level. In a number of countries, employment in the fishing industry is also an important objective in fisheries management. An important question when attempting to improve management then becomes—how much must capacity (*i.e.*, employment) be reduced to achieve these goals?

However, the measurement of capacity also becomes more challenging in renewable resource industries like fisheries because of the effects different management regimes have on incentives and thereby the way fishermen operate. There are also substantial differences with respect to different approaches to capac-

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ity utilization measurement and the information they provide in different settings. When using measures of capacity utilization in fisheries management, one should be very careful in assessing what information these measurements actually convey.

What is Optimal Capacity?

As far as I can see, the most difficult question in measuring fishery capacity utilization is to find a measure of the optimal capacity. All measures of capacity utilization involve a ratio between actual and full, or optimal, capacity utilization, and this is accordingly a key measure. However, the special nature of the fishing industry makes optimal capacity very difficult to measure. In particular, the importance of the state and variability of the stocks and the changes in economic incentives due to different management regimes makes capacity measurement in fisheries very different from traditional industries. This also makes the measure of full (or optimal) capacity very important but very difficult to obtain in practice. In theory, full capacity utilization is obtained when a fishery is optimally managed in an economic as well as a biological sense. While this is a clear reference point, it is extremely difficult to measure empirically. If one deviates from this point, is it along the optimal cost schedule given the stock or is it along the rent dissipating revenue schedule? As shown by Homans and Wilen (1997), the difference can be substantial.

In applied work, one has to measure full capacity in one way or another. In the technical inefficiency literature—the parametric using Stochastic Frontiers (SF), as well as the nonparametric using Data Envelopment Analysis (DEA)—this is generally taken to be the most efficient observation in the data set. For instance, Dupont *et al.* (2002) states that, "the analysis is restricted to observed output-input relationships." However, as discussed by Wilen (2007), while the best firms are likely to be close to, if not at, full capacity in a sample of agricultural firms, the issues with respect to stock and management systems are likely to make a substantial difference with respect to what is the best observed capacity. Thus, with this approach, one has no way to assess how far the best firm in the sample is from the best firm in an optimally managed fishery.

A different approach follows Morrison (1985) and is based on estimates of cost, revenue, or profit functions as in Squires (1988), Dupont (1990), Bjørndal and Gordon (1993), and Weninger (1998) where either the output or some input factors can be treated as fixed. Using this approach, one can solve for the optimal level of a fixed output or input, and accordingly, one is not restricted to the best practice in the sample. With such parametric models, model stability is of course an issue, and one must assume that the fishermen use a similar technology in an "optimal" management situation as in the management situation under which the data was collected. This can be reasonable when one moves from open access to an optimally managed fishery as well as from individual nontransferable quotas to transferable quotas (ITQs) if the harvesting technology does not change substantially from one management system to the other. However, it can be very problematic when going from regulated open access, restricted access, or any other command and control regime with some race to fish incentives to management systems with substantially changed economic incentives and harvesting technologies.

Using a parametric approach, Dupont (1990) and Weninger (1998) also compute optimal fleet size (conditioned on stock and technology). Dupont (1990) finds that in the Canadian Pacific salmon fishery, 22% of the vessels and 37% of the tonnage are redundant. In the U.S. surf clam and quahog fisheries, Weninger (1998) finds that a fleet of 128 vessels can be reduced to between 21 and 25; *i.e.*, a reduction of about four-fifths of the number of vessels, when individual vessel quotas (IVQs) are introduced. These results are also comparable to what has been observed in Iceland and other countries where ITQs have been introduced, as number of vessels has been reduced by as much as 50% and more. These estimates are also higher than those commonly found in studies where one measures capacity utilization relative to best practice in the sample, as in the technical inefficiency literature.

To find optimal fishing capacity, one also needs to take the biological aspect of fisheries management into account and find the optimal stock size and harvest. This requires bioeconomic modeling. However, as shown by Homans and Wilen (1997), the differences can be dramatic, as they found optimal capacity to be only one tenth of regulated open-access capacity. If one also takes into account the impact of changes in harvesting practices and revenues due to changed incentives in different management regimes as in Homans and Wilen (2005), the difference between the alternative management situations can be even more substantial. These results indicate that bioeconometrics, as advocated by Smith (2006), is a more appropriate approach. However, such models are far from trivial to estimate. Furthermore, they may continue to encounter issues such as over-simplified specifications of effort, as addressed in bioeconomic modeling by Squires (1987). In addition, one still will need to find the optimal stock size. Given changing environmental conditions, such as changing water temperatures and ecological system interactions, that is not an easy undertaking.

Concluding Remarks

There is little doubt that measurement of capacity utilization in fisheries is interesting from a fisheries management perspective, as this is a good indicator of how well a management system works or does not work. However, given the difficulties involved in measuring optimal capacity, one may wonder if it is able to provide anything more than an indication of the magnitude of the management problem. As discussed above, different approaches to measurement of capacity utilization will, in many cases, give highly varying outcomes as the approach to measure optimal of full capacity varies.

More importantly, as discussed by Wilen (2007), overcapacity is a symptom of poor management, not the cause. Hence, improving capacity utilization should not be a management goal in itself since it requires management of the command-and-control type. The fisheries economics literature clearly shows that such management systems do not work with respect to the economic management of a fishery, as discussed, for example, in Wilen (2000). Hence, different restrictions on capacity or input factor use will, in general, only contribute to the inefficiency in a fishery. Moreover, from a fisheries management perspective, buyback programs do not work, although the people who receive the money transfer certainly benefit.

The main message that comes from the empirical literature is that the overcapacity in many fisheries is substantial, as indicated for example by Dupont *et al.* (2002), Weninger (1998), and Homans and Wilen (1997), each using different empirical or theoretical approaches. Their results indicate that the excess capacity is at least half the number of vessels in a fleet, making more than half the fleet redundant. This also implies that any capacity reducing scheme, such as buyback programs that target a small percentage of the capacity, will most likely not have any impact from a management perspective.

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