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Fisher participation in monitoring: Does it help reduce excessive investment in fishing capacity?

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ABSTRACT

The problem of excess capacity has persisted in many fisheries worldwide, threatening the sustainability of fisheries, even in cases where there are regulatory restrictions on fishing inputs. Getting fishers involved in monitoring illegal fishing has been one of the solutions proposed to tackle excessive investment in fishing capacity. However, the real effects of participation in monitoring have not yet been investigated in a rigorous and quantitative way. Using survey data for small-scale fisheries under a Territorial Use Rights for Fisheries (TURFs) system in Vietnam, this study measures the extent of excess capacity at individual fisher level using a bootstrapped Data Envelopment Analysis and investigates the effects of fisher participation in monitoring on level of excess capacity by employing an Endogenous Switching Regression model. We find evidence of substantial excess capacity even under TURFs, with fishers on average operating at 59% capacity. However, the results also show that participation in monitoring contributes to a significant reduction in excess capacity. Non-monitors are likely to have short-sighted investment behavior while monitors are likely to be driven by perception about the management of TURFs, and long-term incentives in their investment behavior. Age, education, and alternative livelihood also help explain the variation in the level of excess capacity among fishers. Knowledge of the drivers of fisher investment are of critical importance to policy-makers to establish effective capacity management interventions. Engaging fishers in monitoring should be considered as one of the key strategies for reducing excess capacity. To promote fisher participation in monitoring, effort should be directed towards enhancing awareness of the consequences of illegal fishing and building fisher trust in peers and local government officials.

1. Introduction

The crucial role of getting fishers engaged in monitoring to tackle the problem of illegal fishing has been emphasized in the existing literature (Crawford et al., 2004; Danielsen et al., 2009; Davis et al., 2015). Such engagement would not only reduce enforcement costs borne by the government (Brown et al., 2017) but could also enhance fishers' understanding of the impacts of fishing regulations on the abundance of fish stocks, as well as on the sustainability of their livelihood (White and Vogt, 2000). These in turn foster good relationships between fishers and local authorities and improve fishers' management capacity of the resources (Danielsen et al., 2009).

There is also some evidence suggesting a positive link between fishers' management capacity (an aspect of human capital), and investment behavior. Specifically, fishers with better management capacity (e.g., decision skills, knowledge of management tools, and understanding of monitoring and evaluation systems) are less likely to race to invest in fishing inputs (e.g., in fishing vessels or gear) (Wilson et al., 2003; Stevens et al., 2015; Gurney et al., 2016). Myopic or short-sighted investment and resource use behavior among fishers tends to be weakened as fisher engagement in management activities helps raise awareness about the necessity of supporting and complying with management rules (Castilla et al., 1998; Mease et al., 2018), improve perceptions about legitimacy of fishing rules, and promote a sense of security and ownership over the resources (Gelcich et al., 2008; Jagers et al., 2012; McLain et al., 2018). Such positive perceptions appear to reinforce sustainable resource use behavior among fishers (Gelcich et al., 2008). Therefore, one may expect that participation in monitoring could change fishers' investment behavior in more sustainable ways. However, to date no study has examined the real impact that participation in monitoring has on fisher investment behavior in a rigorous and quantitative way. This study aims to fill the gap.

Gaining an understanding of the factors affecting fisher investment behavior is of critical importance to resource managers, as globally fisheries are suffering from a problem of excess capacity, which inhibits sustainability of fisheries development (Idda et al., 2009; Rust et al.,

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2017). Excess capacity occurs when the amount of fishing capital is greater than the minimum amount required to harvest a given fish stock at the least cost (Greboval, 1999). This problem is particularly serious in open access or common pool fisheries with ill-defined property rights (Kirkley et al., 2003; Pascoe et al., 2012). Such fisheries create an environment where the race to fish leads to inefficient or excessive investment in capital (Emery et al., 2014). Excess capacity results in economic waste and makes harvest levels difficult to manage or control, consequently leading to overfishing and stock depletion (Clark, 2006; Salayo et al., 2008). It also raises other issues, such as negative spillovers to other fishing areas and resource conflicts (Munro and Clark, 1999). In some regulated fisheries where incentives to overinvest have not been eliminated, excess capacity contributes to illegal fishing because fishers are likely to overfish to offset their costs (Huang and Chuang, 2010).

Although the negative effects of excess capacity have long been recognised, there is still overwhelming evidence of continued capacity building worldwide, even in regulated fisheries where some management systems (e.g. buyback programs, and gear/vessel restrictions) have been put in place to address the issue (Clark, 2006; Pomeroy, 2012). This is due to the fact that these management systems do not correct the deep-rooted incentives that create the problem – the absence of well-defined property rights (Cox, 2007). By contrast, Territorial Use Rights for Fisheries (TURFs), known as a spatial form of rights-based management tool, provide individuals or group of fishers with clearly-defined property rights: access privileges and fishing rights to exploit resources within a designated area (Christy, 1982; Villenaa and Chávezb, 2005). In theory TURFs have high potential to eliminate the race to invest among fishers, thereby addressing the problem of excess capacity (Metzner, 2005; Nguyen et al., 2017). Such potential is largely based on whether regulations associated with TURFs are well-enforced by a strong compliance monitoring, control, and surveillance system (Nguyen et al., 2017). Therefore, encouraging active participation in monitoring by fishers is likely to be an essential element for achieving the effectiveness of TURFs.

Using survey data from a case study of small-scale fisheries in Tam Giang lagoon, Vietnam where TURFs have been implemented, our study aims to address the following research questions: 1) To what extent does excess capacity occur at individual fisher level within a TURF system? 2) What factors affect fishers' decisions to monitor and to invest in fishing capital? and 3) Does fisher participation in monitoring reduce his/her level of excess capacity? To answer these questions, a bootstrapped Data Envelopment Analysis (DEA) with an output-oriented approach was employed to measure fishing capacity and level of excess capacity. An Endogenous Switching Regression Model is then used to explore the determinants of fisher's decisions to participate in monitoring and to elucidate capital investment by fishers, and also to investigate how participation in monitoring relates to the level of excess capacity.

This study makes several original contributions to our current knowledge on fisheries management. First, this is the first attempt to measure the level of excess capacity among individual fishers in a TURF system. We have employed a bootstrapped DEA, which rectifies estimation problems in standard DEA method. We are not aware of any prior work that employs a bootstrapped DEA to deal with the bias of fishing capacity estimates due to sampling variations. Second, our study is the first quantitative research to specifically investigate changes in investment behavior brought about by participation in monitoring, contributing to the scant literature on examining factors affecting fishers' investment decisions (Nøstbakken et al., 2011; Jensen et al., 2012). The results from our study should improve our understanding of the relationship between excess capacity and its drivers, which in turn should provide policy makers with insights into improving excess capacity management policies.

The remainder of this paper is structured as follows. Section 2 presents a definition of fishing capacity and its related measures. Methods used in the analysis are described in Section 3. Section 4 briefly provides background information on the study area and survey design. Section 5 reports and discusses the main findings. Section 6 concludes the paper by providing some implications for capacity management policies.

2. Definition of fishing capacity and its related measures

Johansen (1968) proposed a definition of plant capacity: "…the maximum amount that can be produced per unit of time with existing plant and equipment, provided the availability of variable factors of production is not restricted". This definition has then been modified and adapted by FAO (1999) for fisheries. Accordingly, fishing capacity[1] (capacity output) is defined as the maximum amount of fish that can be produced over a period of time by a vessel or a fleet given the set of fixed inputs (capital utilized), existing fish biomass, and applicable fishing regulations but in the absence of variable input constraints. This is a short-term concept, as fishing capacity could vary with stock fluctuations in a stock-flow production technology system.

Capacity Utilization (CU) reflects the proportion of available fishing capacity that is utilized (Morrison, 1985), thereby providing an indicator of the extent to which excess capacity occurs at individual-fisher level (Tingley et al., 2005; Rust, 2016). CU is computed as the ratio of observed (actual) output (Y) to capacity output (Y_C) (Morrison, 1985).

$$CU = \frac{Y}{Y_C} \tag{1}$$

CU estimates may be biased downward because the observed output may not be produced in a technically efficient manner (Fare et al., 1994). Technical efficiency (TE) under an output-orientation approach is defined as the maximum amount of outputs that a fisher could produce from a given set of inputs. In other words, there are two sources of output shortfall: one is that a fisher might fail to produce the technically efficient level of output for a given set of inputs (fixed and variable), and the other is underutilization of fixed input (fishing capacity underutilization) due to variable input limitations. Unbiased capacity utilization measure (CU_u) removes the effect of technical efficiency and is computed as a ratio of technical efficient output (Y_{TE}) to capacity output (Y_C) (Fare et al., 1989). The value of CU_u ranges from 0 to 1. A CU_u estimate of less than 1 indicates the presence of excess capacity while a value of 1 indicates full utilization (Dupont et al., 2002).

$$CU_u = \frac{Y_{TE}}{Y_C} \tag{2}$$

Fig. 1 illustrates efficient output (Y_{TE}) and capacity output (Y_C) assuming that there is a fisher operating at point A using fixed inputs (F_X) (e.g., vessels, gross tonnage, and fishing gear) and variable inputs V_X (e.g., fishing time) to harvest Y quantity of fish. The actual output achieved is not efficient as it is below the efficient output (Y_{TE}) at point B on the production frontier that is achievable without requiring extra inputs. However, the efficient output (Y_{TE}), which is constrained by the current level of variable input use (V_X), is below the capacity output (Y_C) at point C that can be attained by using the optimal amount of variable inputs ($V_X{}^*$). Increasing the amount of variable inputs beyond $V_X{}^*$ does not increase output as fixed inputs constrain production to Y_C.

3. Methods

This section describes the DEA framework to compute efficient output (Y_{TE}) and capacity output (Y_C) and generate bias-corrected estimates of capacity utilization. This is followed by the specifications of Endogenous Switching Regression Model used to investigate the impact

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[1] Investment contributes to a stock of capital. Capital stocks are equated to fishing capacity. Particularly, investments in technical capital (e.g. vessel, engine power, and fishing gear) determine fishing capacity (Nøstbakken et al., 2011).