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Excess capacity and efficiency in the quota managed Tasmanian Rock Lobster Fishery

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ABSTRACT

Excess capacity is a major concern for fisheries management worldwide. It is often argued that Individual Transferable Quota (ITQ) systems will enhance efficiency and alleviate problems of excess capacity. While improvements in efficiency have been observed, most empirical studies have found only modest changes in excess capacity as a result of such systems. Using a database of compulsory log-book information for the Tasmanian Rock Lobster Fishery in Australia, from January 2000 to December 2013, this study presents the first analysis to investigate the dynamic behaviour of both excess capacity and efficiency (i.e. technical and scale efficiency) in an industrialised fleet after the introduction of quota management. The analysis revealed weak evidence for a prolonged adjustment in the fishery following the introduction of an ITQ system. In addition, no marked changes in excess capacity were observed over the study period; and furthermore, there was no evidence for an increase in excess capacity during a period of non-binding Total Allowable Catch (TAC) when race to fish behaviour increased in the fishery. The results suggest a limited ability of the ITQ system to alleviate levels of excess capacity in fisheries in the long-term.

1. Introduction

Controlling the emergence of new, and managing existing, fishing capacity is of major concern to fisheries managers and policymakers worldwide [41,15,14,46]. Excess capacity is prevalent in fisheries where there are incentives for race to fish and race to invest behaviour by the fishery's participants [56,30,40,48]. In terms of the overall fishery, excess capacity occurs when the fishing capacity significantly exceeds the level of harvest that is observed from the fishing fleet, and this represents economic waste in the sense that the total harvest could be taken with a smaller investment in fishing capacity [49,6,25]. Such waste not only raises the potential for the spill-over of fishing effort between fisheries, but also signals opportunities for the improvement of the fishery's performance.

It is commonly argued that the implementation of an Individual Transferable Quota (ITQ) system can eliminate the race to fish and improve both biological and economic outcomes for the fishery [24,8,4]. An ITQ system firstly establishes a Total Allowable Catch (TAC) control that limits the fishery's harvest, and then allocates a set number of transferable rights to the TAC that can be traded.[1] Although contentious in the literature, it is often argued that the trade in these rights will encourage the transfer of fishing effort from less efficient to more efficient fishers [20,42,38]. The reduction in vessel numbers that occurs as the less efficient fishers exit the fishery also has the potential to reduce or eliminate levels of excess capacity. Since the total harvest of the fishery is shared among fewer vessels, the production of the most efficient vessels may approach their fishing capacity and thereby reduce excess capacity. The reduction in vessel numbers, and accompanying decline in excess capacity, can occur quickly, or may be drawn out over a number of years, depending on factors such as the availability of alternatives for the incumbent fishers or functioning of the quota sale and lease markets [21,54,59].

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[1] The ITQ system is one form of incentive based system for fishing regulation. Incentive-based systems involve the allocation of individual vessel quotas that are either based on the quantity of catch, or represent a specific spatial distribution of the harvest rights [1]. Systems of spatially distributed harvest rights are referred to as Territorial Use Rights for Fishing (TURFs), and allocate an exclusive right to catch fish from a given area of a fishery. In quantity-based systems, each vessel quota represents the right to harvest some proportion of the TAC in the fishery [24,8]. In quantity-based systems, vessel quotas may be non-transferable or transferable. When vessel quotas are non-transferable they represent an allocation of catch to individual vessels that cannot be purchased or sold by the operators [2]. When vessel quotas are transferable, the operators in the fishery trade quota rights between themselves and thereby establish a quota market [20]. Incentive-based systems where vessel quota is both transferable and quantity based are commonly referred to as 'ITQ systems'. The Tasmanian Rock Lobster Fishery has an ITQ system [29] which has been widely studied [3,18,27,58,57,13] since its inception in the 1998 quota year.

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The success of ITQ systems at eliminating the race to fish depends on a number of factors, which include: effective governance [28]; a strong monitoring, control and surveillance system [43]; and critically on implementing a binding TAC constraint [35,23,34]. When the TAC is non-binding, the fishery can revert to a regulated open access or limited entry paradigm [13,35,23,34] in which the incentives for race behaviour are well known and lead to an increase in fishing effort [13,35]. Periods of non-binding TAC have been observed in the northern zone of the South Australian rock lobster fishery [37,39], the Australian South Eastern Trawl Fishery [34,12], and also in the Tasmanian Rock Lobster Fishery [13]. Studies of these fisheries overwhelmingly find an increase in fishing effort due to the non-binding TAC and, in some cases, a decline in the total value of the harvest [34,12].

In the Tasmanian Rock Lobster Fishery, Emery et al. [13] associated a period of non-binding TAC with an increase in the temporal concentration of fishing effort (i.e. pot lifts) and a decline in the price of 'quota' or 'catch shares'. There are many non-fishing quota owners in this fishery who lease the right to harvest catch quota for a single fishing season at the prevailing market price to 'lease' fishers that operate vessels and take the catch [58,57]. When the TAC is non-binding, the drop in the lease price of quota allows the entry of latent vessels [13] that are operated by fishers who normally cannot afford to harvest at the higher constrained quota price.

A small number of studies have compared excess capacity and efficiency before and after the introduction of an ITQ system. These studies overwhelmingly find evidence for only a small reduction in excess capacity following the introduction of such systems [11,53], although some do find a more significant change. For instance, Squires et al. [55] investigated excess capacity before and after the introduction of an ITQ system, and found reductions in excess capacity over a longer time period. In the case of efficiency, Soliś et al. [51] found that the introduction of quota management improved technical efficiency in the fishing fleet over time, and that these changes were likely due to the exit of inefficient vessels and the easing of command and control regulations (e.g. trip limits and season length restrictions). Grafton et al. [22] also found that the short run efficiency gains from privatisation may take a number of years to materialise. However, none of these studies has directly investigated the temporal (i.e. dynamic) behaviour of excess capacity and efficiency in an ITQ-managed fishery; nor was there any investigation of changes in excess capacity and efficiency during a period of non-binding TAC.

Using compulsory log-book data, this paper applies Data Envelopment Analysis (DEA) to investigate the dynamic behaviour of excess capacity and efficiency in the Tasmanian Rock Lobster Fishery in Australia from January 2000 to December 2013. The Tasmanian Rock Lobster Fishery has been quota-managed since the 1998 quota year [29], and from the 2008 to the 2010 quota years was subject to a non-binding TAC [29,13]. Both technical and scale efficiency [7], as well as unbiased capacity utilisation [33], are measured for the fishery over this period. The estimates are used to explore the relationship between excess capacity, efficiency and the race to fish, through investigating: (1) whether the fishery's adjustment occurs over a lengthy period of time following the introduction of ITQs; and (2) if the pattern of excess capacity and efficiency reflects the increase of race to fish behaviour during a period of non-binding TAC.

2. Methods

2.1. Measuring capacity utilisation and efficiency

This paper measures unbiased capacity utilisation as the ratio of the technically efficient output for vessel j in season t divided by the capacity output for that vessel in season t [33], i.e. $CU^{(j,t)}=Y_{TE}^{(j,t)}/Y_{C}^{(j,t)}$, where $CU^{(j,t)}$ is the vessel's unbiased capacity utilisation, $Y_{TE}^{(j,t)}$ is its technically efficient output and $Y_{C}^{(j,t)}$ is its capacity output. Technically efficient output refers to the maximum output that can be obtained from a given set of inputs when output is constrained by the availability of both the fixed and variable inputs [7,17] and is measured using the output-orientated DEA approach as per Coelli et al. [7]. Output-orientated technical efficiency is measured at the same time as technical efficiency, according to this approach. Capacity output represents the maximum output that can be produced in a period of time, given normal or customary operating conditions, with existing plant and equipment and provided that the availability of variable factors is not restricted [44,32,31], and is also measured using the output-orientated DEA approach as presented in Färe et al. [16]. In both cases we assume the production technology potentially exhibits Variable Returns to Scale (VRS) [16,26].

Another efficiency measure used in the paper is the scale efficiency, which is a measure of the efficiency loss that occurs due to a deviation from the technically optimal production scale for a VRS production technology. We measure scale efficiency as the ratio of the VRS technically efficient output to the Constant Returns to Scale (CRS) technically efficient output [7]. The vertical distance between the VRS and the CRS technologies represents the amount of output that is foregone due to lower productivity at the current scale of operation.

The use of output-orientated DEA is more practical for capacity measurement, but has the limitation that it assumes the output of individual vessels can be expanded for a given set of vessel inputs (which may not be the case in quota fisheries, where catch is controlled). The alternative for measuring technically efficient and capacity output is termed input-orientated DEA, and this method searches the production data for combinations of the data points that minimise the use of inputs for a given level of output. A practical issue arises with this approach in the case of capacity measurement, where the fixed inputs of the fishery are assumed to be static at the vessel level.

3. The Tasmanian Rock Lobster Fishery and data

3.1. The Tasmanian Rock Lobster Fishery

Fishing for southern rock lobster (*Jasus edwardsii*) occurs across Southern Australia and is managed by different state jurisdictions, including Victoria, South Australia and Tasmania. Entry to the Tasmanian Rock Lobster Fishery is limited with 312 licenced operators in 2012–13 [10], however not all of these licences were active in the fishery in that year and these do not constrain the catch (i.e. catch is limited through the price of quota, under normal conditions). On average from the 2009–10 fishing season to the 2011–12 fishing season there were 234 active vessels in the fishery [29], which indicates the presence of latent effort that has the potential to re-activate at low quota prices [13]. The commercial fishing season for rock lobster runs from March to February, with a closure in place for the majority of the state in September, and for the whole state during October to protect moulting lobsters. The rock lobster fishery has been subject to an ITQ system, supplemented by size limits and gear restrictions, since the beginning of the 1998 quota year [19]. The gear limit was raised from 40 to 50 pots per vessel at the time the ITQ system was introduced. To account for geographical variation in the fishery, a single TAC for the commercial fishery is set each year using a spatially-explicit model that divides the fishery into the eleven stock assessment areas shown below.

Settlement of larvae from the water column is unevenly distributed around the state and depends on factors including ocean currents [45]. The productivity of the fishery also varies by region due to differences in growth and survival. In the 2011-12 fishing season [29] the west coast stock assessment areas were responsible for 45.2% of the total catch of the fishery. Those on the east coast recorded 28.7% of the catch and the stock assessment area surrounding King Island was responsible for 26.1%.

The rock lobster fishery contains a number of different industry