Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

18-Mar-2004

English - Or. English

DIRECTORATE FOR FOOD, AGRICULTURE AND FISHERIES
FISHERIES COMMITTEE

AGR/FI/IUU(2004)4
Unclassified

Cancels & replaces the same document of 17 March 2004

Incentives for Investment in IUU Fishing Capacity

19-20 April 2004

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It is submitted to the IUU workshop, 19-20 April 2004

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JT00160351

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SUMMARY

Considering investments in IUU fishing as "normal" investment decisions, this paper utilises a simple investment model in order to examine the concern that levels of investment in IUU fishing might be driven by a "spillover" of excess capacity from regulated fisheries. The available evidence suggests that this is rather unlikely. If IUU fishing is relatively profitable, as seems to be the case, most of the investment in IUU capacity will occur whether or not "cheap" capacity is available as a result of the subsidised removal of excess capacity from regulated fisheries. It appears that IUU fishing will only be of marginal profitability if costs are significantly increased or revenues significantly reduced as a result of enforcement efforts to deny vessels access to the fishery and/or lucrative product markets.

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1. Introduction

1. This paper presents an economic analysis of the fishery investment decision in the context of investments in IUU fishing. The aim is to understand how incentives to invest in IUU fishing may differ from incentives to invest in legal fishing and, in particular, to consider the importance of the cost of *capacity* in such investment decisions. Given the widely acknowledged existence of excess capacity in many regulated fisheries, and the efforts of policy makers to encourage the removal of this excess capacity, we might question whether there is likely to be an associated "spillover" effect on the supply of investments in IUU fishing. The paper attempts to address this issue. To begin with, however, it is useful to review exactly what is meant by IUU fishing and to briefly consider, in economic terms, why it is a problem. It is also necessary at the outset to clarify what we mean by fishing capacity, and then to narrow the focus of the paper in order to facilitate discussion.

2. IUU means "Illegal, Unreported and Unregulated". The term was first used by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) but is now widely employed, in particular by the UN/FAO. The definition of IUU fishing set out in Paragraph 3 of the 2001 International Plan of Action (IPOA) on IUU fishing (FAO 2001), adopted within the framework of the FAO Code of Conduct for Responsible Fisheries, is included here in Appendix 1. It is apparent from this definition that IUU covers a rather wide variety of undesirable fishing operations and practices, from legitimate operations cheating at the margins (for example, exceeding catch quotas or retaining and landing a proportion of under-sized fish) to entirely illegal operations with no entitlements to take fish in any regulated area. The term "unregulated" also includes vessels fishing in areas subject to international regulation but which are flagged to States not party to the relevant Convention. In addition, the FAO definition covers vessels fishing in areas where no national or international regulations apply, but excludes cases in which the relevant flag State nevertheless fulfils all its obligations under international law.

3. The reason why IUU fishing is a problem might appear straightforward, although, strictly speaking, the direct impact of IUU fishing is undesirable in economic terms only if it imposes a net social cost. This will certainly be the case if the costs imposed, for example, in the form of reduced benefits in the future from exploitation of a depleted fish stock exceed the current benefits to producers and consumers from IUU fishing (which, it should be appreciated, are very likely to be positive). Almost by definition, however, IUU fishing will impose such costs as a result of stock damage since, as a rule, fishery regulations exist in order to restrict fishing mortality to levels which, if not socially optimal, are at least sustainable. We may then assume that if regulations are not complied with, fishing mortality will be excessive. The main problem with IUU fishing, therefore, whether it takes the form of individual vessels exceeding their legal exploitation limits at the margins or vessels having no legal right to fish at all, is that in most situations fishing mortality is increased to a level which is economically damaging. It is arguable that IUU fishing, according to its broadest definition, is as much of a problem in this regard in many regulated fisheries within EEZs as it is in the high seas fisheries of the Antarctic or the Indian Ocean. IUU fishing may also impose economic costs on society in the form of damage to non-target species, in particular highly "environmentally-valued" species such as seabirds and cetaceans. However, while IUU fishing vessels might be especially guilty of such incidental damage (see, for example, Agnew 2000), the problem is by no means confined to this sector.

4. The indirect economic impacts of IUU fishing could be at least as serious. The visible presence of vessels fishing illegally may encourage other vessels to violate regulations, since it signals weak enforcement and may undermine the perceived stock-related benefits from regulatory compliance. IUU fishing will also significantly reduce the quality of landings data available for stock assessments and hence severely compromise the ability of managers to set proper exploitation targets.

5. It should be appreciated that in this paper we are not employing the term "capacity" in a strict economic sense, but rather in the sense in which it is commonly employed by fishery managers and policy makers. In economics, capacity is a short run measure of unconstrained (and efficiently produced) output from a given (fixed) level of capital stock and a given production technology. There are various alternative precise definitions of capacity but the most straightforward, conceptually, is the short run potential output which maximises profits, given current input and output prices. Clearly, there can be problems in defining capacity in practice and these will be particularly difficult in the context of the fishery, where there are generally multiple outputs and fluctuating prices and the unpredictable nature of the resource (not to mention the weather) means that output is stochastic and may often be limited to below potential.[2]

6. In the arena of fisheries management and policy, "capacity" is generally used to mean both potential output by a fishing vessel (or a fleet of fishing vessels) *and* the amount of physical capital which generates that output. Although this may not be correct, all else equal, for a given stock of capital, existing technology, current prices, etc., capital and capacity can be considered closely related and therefore interchangeable for most practical purposes. For example, the terms "capacity" and "overcapacity" are often used in relation to desired levels of output such as a TAC to refer to the amount of capital (or fleet size) required to harvest that output at least cost. Thus, a situation of overcapacity or excess capacity is one in which the TAC could be harvested efficiently by a smaller fleet, or (perhaps more likely in practice) the existing fleet (efficiently) takes a larger catch than that desired by managers.

7. Given the very broad definition of IUU fishing adopted by the FAO, we do need to restrict our focus somewhat in this paper. What we are principally interested in here are vessels operating outside of any regulatory regime and, for the most part, outside of EEZs. This includes vessels participating illegally in high seas fisheries which are regulated under international fishery conventions, such as the highly valuable illegal fishery for toothfish in the Southern Ocean (see Agnew 2000). Generally, these vessels are either registered in States not party to the relevant convention or in States which *are* party to the convention but which exercise no meaningful control over vessels flying their flag. Although such vessels are often referred to as "flag of convenience" (FOC) vessels, the CCAMLR uses the term "flag of non-compliance" (FONC) to emphasise that the choice of flag State for IUU fishing vessels is determined, to a great extent, by the lack of regulatory control that will be exercised over them (see Agnew and Barnes 2004). We could also, however, include vessels fishing illegally within the EEZs of States which have few resources available to devote to enforcement. What all these vessels have in common is that they have no right of access to the fishery in question and operate free of any effective regulation. Our focus is therefore on the *absence* of management rather than on the inadequate management of

[2] For a discussion of the concepts of capacity and capacity utilisation in fisheries see Kirkley and Squires (1999), Kirkley, Morrison Paul and Squires (2002) and Kirkley and Squires (2003).

vessels which do enjoy a basic access right. The significance of this is that, in the absence of management, the supply of capacity to the fishery will depend only upon market forces, i.e., the free interplay of demand and supply. A corollary to this assertion is that if we need to be concerned with, say, the supply of capacity to a fishery, then *de facto* we have a situation of management failure (given this, it should be apparent that management failure is not wholly confined to illegal high seas fisheries).

8. In the next section we set up a simple model for a fishery investment decision and in Section 3 we consider how this might look in the context of investments in IUU fishing. Section 4 then addresses the possible effects of different capacity supply prices on the level of capacity in IUU fishing. A final section presents some concluding comments.

2. A model for fishery investment

9. Let us assume that the decision to invest in IUU fishing, as we have more narrowly defined it, is taken as a normal investment decision, i.e., it is based upon the expected net return from the investment over its anticipated life. Thus we assume that the investor neither wants to fish illegally for the sake of it, nor is he deterred to any significant degree by a moral objection against such an activity. In simple terms, given the opportunity to purchase a suitable fishing vessel, the decision to invest in either legal or illegal fishing depends only upon the balance of expected returns against the purchase price. To begin with, we will consider what determines those expected returns in a (legal) fishery and hence what should determine the purchase price of capacity in a perfectly competitive market. In the following section, we can then look at how the investment decision may change in the context of IUU fishing.

10. The present value (PV), evaluated over T years, of the stream of annual profits from an investment in an amount of fishing capacity (or physical capital) K at time $t = 0$ is given by

$$PV = \sum_{t=1}^{T} \rho^t \bar{\pi}_t(K), \qquad (1)$$

where a discount factor ρ is defined as

$$\rho \equiv \frac{1}{1+\delta},$$

with δ being the appropriate annual discount rate (assumed constant). The (expected) gross operating profit $\bar{\pi}_t(K)$ in year $t = 1,2,...T$ is given by

$$\bar{\pi}_t(K) \equiv p_t \bar{q}_t(K) - \mathbf{c}_t(K), \qquad (2)$$

where $\bar{q}_t(K)$ is the (expected) catch at time *t* and p_t is the (expected) market price received for that catch.[3] Total operating costs $\mathbf{c}_t(K)$ are assumed to be made up as follows:

$$\mathbf{c}_t(K) \equiv c_t^r(K) + c_t^c(K) + c_t^m(K) + c_t^a(K) + c_t^p(K) \qquad (3)$$

where $c_t^r(K)$ are normal running costs (fuel, ice, etc.), $c_t^c(K)$ are crew costs (wages), $c_t^m(K)$ are routine maintenance costs (running repairs to the vessel and its gear, plus the provision and maintenance of safety equipment) and $c_t^a(K)$ are administrative costs (which include costs arising from flag state registration, safety certificates, insurance, etc.). The final category of costs, $c_t^p(K)$, includes the (rental) costs of any fishing permits, such as licences or quota allowances. Of course, in many management regimes marketable permits are not used to allocate fishing rights and the vessel may face a fixed catch or effort limit. In this case $c_t^p(K)$ might be zero but the expected catch $\bar{q}_t(K)$ would be constrained to less than the potential for the vessel.

11. The *total* expected return (*ER*) from investing in *K* is given by (1) plus the discounted value of the capacity at the end of the period, which we will denote C_T, so that

$$ER = \sum_{t=1}^{T} \rho^t \bar{\pi}_t(K) + \rho^T C_T. \qquad (4)$$

12. If *K* were a truly riskless asset, then in a perfectly competitive asset market at equilibrium we would expect the initial cost (capital value) C_0 of capacity *K* to equal *ER*, its expected return (which would in fact be a *certain* return). If it were greater than this, no-one would invest in the asset, while if it were less than this the demand for the asset by potential investors would push the price up to equal *ER*. Fishing, even when legitimate, is by no means a riskless enterprise, however. If we assume that the discount rate δ applied in the above is equal to the market interest rate *r* for a safe investment (such as a Government bond), then the investor will expect a higher (average) return from investing an amount C_0 in fishing than he would from investing in the safe (riskless) asset. Equivalently, for a given investment in fishing the investor would only be willing to pay an amount *less* than *ER*. One way to model this is to deduct a *risk premium*, *R*, from the expected total return on the fishery investment so that

$$C_0 = \sum_{t=1}^{T} \rho^t \bar{\pi}_t(K) + \rho^T C_T - R, \qquad (5)$$

i.e., the market cost of *K* (here C_0) is less than the cost of a safe investment yielding the same expected return. To be clear, C_0 represents the maximum *willingness to pay* (WTP) of

[3] For simplicity, we can think of *K* as defining the size of a given type of fishing vessel, with the expected (average) annual output (catch) *q* assumed to be an increasing function of *K*, i.e., $dq(K)/dK > 0$, so that, on average, a larger vessel will produce a higher annual catch.

investors for fishing capacity *K*. Investors will not pay more than C_0 for *K*, although they would certainly be prepared to pay less than C_0 if such an offer were made. In a perfect market, however, where there are many potential investors, the equilibrium (market) price for *K* will equal C_0, for the reason previously advanced.

13. It is apparent from (5) that, all else equal, higher expected profits $\bar{\pi}_t(K)$ mean that C_0 will be higher. A reduction in C_T, the expected resale value of the vessel (capacity) at time *T*, will lower C_0, as will an increase in the riskiness of the investment and hence an increase in *R*.[4]

14. For an individual already participating in the fishery, C_0 represents the *opportunity cost* of remaining in the fishery. Assuming an absence of non-pecuniary motivation, C_0 is the minimum amount that would have to be offered to the individual in order to entice him to disinvest, i.e., to exit the fishery. Note that this *includes* any amount received from the disposal of the vessel: indeed, in a perfect market for fishery investments, as we have observed, this would be the entirety of C_0.[5]

3. Incentives and disincentives for investments in IUU fishing

15. Having set out a model for investment in fishing, albeit a greatly simplified one, we can now examine how incentives to invest in IUU fishing might differ from incentives to invest in a legal fishery, considering firstly the expected returns from IUU fishing as compared to returns from legal fishing. There are a number of reasons why revenues and operating costs in an IUU fishery are likely to differ from those in a legal fishery (see Agnew and Barnes 2004 for a fuller discussion of the typical modes of operation of IUU vessels). These can be briefly summarised as follows:

> *Revenues*. In general, IUU vessels target only the most valuable species (such as toothfish, tuna, squid, etc.). Expected revenues are therefore likely to be high, even if access to legitimate markets is made difficult by port controls or some type of catch certification scheme (Agnew 2000). Efforts to deny IUU vessels access to legitimate markets can be circumvented in various ways, however, including the transshipment of catches at sea to vessels which do have access to such markets. In addition, the absence of management means that there are no constraints on catches other than those imposed by the natural environment (the stock, the weather, etc.).

[4] The analysis of risk and the behaviour of asset markets is a large topic (see, for example, Varian 1992, Chapter 20, and Hirshleifer and Riley 1992). We can think of *R* as being related to the extent to which higher or lower returns than *ER* are perceived as likely, i.e., to the *variance* of returns. Note that individual investors may differ in their judgement about the riskiness of the investment and also in their attitudes to risk. Hence C_0 may vary across individuals.

[5] This follows directly from our expression for C_0: at the time of disinvestment future expected returns and (hence) the risk premium are zero so that $C_0 = \rho^0 C_{T=0} = C_0$.

Running costs. We may assume that variable inputs such as fuel, lube, ice and so on can be accessed, one way or another, at prevailing market prices, even if direct access to normal port facilities may be denied by some countries. The *use* of fuel, however, may be relatively high due to increased steaming time to distant fishing grounds in international waters and also to the need to undertake evasion activities such as seeking refuge in international waters when fishing illegally within an EEZ.

Crew costs. IUU vessels, in common with FOC vessels generally, tend to be crewed cheaply, i.e., using labour from countries where labour costs are low and where there may be few alternative employment possibilities. On the other hand, as observed by Agnew and Barnes (2004), the more senior crew, such as the skipper and engineer, typically from developed countries, may demand rather higher remuneration than they would in a legal fishery due to the risks involved in IUU fishing (in effect, a wage "risk premium") and the relatively longer periods spent at sea.

Maintenance costs. Potentially, maintenance costs could be increased due to prolonged operation in international waters. However, the investment time horizon for IUU fishing may be shorter than in a legal fishery, so that less is spent on maximising the productive life of the vessel and (hence) its potential resale value. Expenditure on non-essential items such as safety equipment is likely to be less, associated with the less stringent registration requirements of FOC States in which IUU vessels are generally registered. FOC registration may also mean that there are no pollutant emissions targets to be complied with. In short, there may be a lesser incentive to maintain the vessel to a high standard, although it would surely be perverse to allow the vessel to become inefficient to the extent that increased harvesting costs exceeded any savings on maintenance costs.

Administrative costs. Also likely to be lower as a result of FOC State registration are various administrative costs such as registration charges, the costs of safety inspections and certification, vessel insurance costs, as well as indirect employment costs such as national insurance contributions. Expenditure on port berthing and landings dues may also be lower.

Management costs may be taken to be zero.

16. Although we assume that IUU vessels are free of any effective regulation, they are nevertheless subject to attempts at apprehension and sanction. The expected annual costs to the IUU investor arising from such attempts are simply given by the expected annual frequency of successful apprehension and sanction multiplied by the expected level of penalties incurred, including forfeiture of catches and any bonds imposed for the subsequent release of the vessel. Given that successful enforcement events may be relatively infrequent, however, particularly for IUU vessels fishing predominantly in international waters (where States other than the flag State have no right of arrest under international law) the expected cost to the IUU investor may be more appropriately deducted from C_0 as an additional risk premium, rather than included as an annual operating cost. Even without the risk of capture, the risk premium for an IUU investment may be somewhat higher than in a legal fishery if, for example, the vessel is less seaworthy because less has been spent on maintenance (or the vessel was in poor condition already) or the skipper is more prepared to take risks with the weather, etc.

17. Finally, in our "capacity value" equation (5) we have C_T, the (resale) value of the vessel at the end of the investment timescale. Clearly this will depend upon a number of variables, including the initial value of the vessel, how well it has been maintained and how long the investment timescale is. If the initial investment is in an old vessel in relatively poor condition, the timescale may be relatively short and C_T may be disregarded entirely.

18. For fairly obvious reasons, there are no datasets available which would enable us to make a definitive judgement on whether the value of an investment in IUU fishing is higher or lower than the value of an investment in the same quantity and quality of capacity in a similar legal fishery (i.e., a legal fishery for the same or similar species in a comparable area). On the basis of available evidence, however, (again, see Agnew and Barnes 2004) it does appear to be the case that net operating returns in IUU fishing are, if anything, relatively high, and probably comparable (I suggest) to returns in a profitable legal fishery. This is perhaps not surprising, given that IUU vessels, as we have observed, generally target highly valuable species and almost certainly face lower operating costs in a number of respects. Unless enforcement and deterrence efforts are sufficiently successful as to add a very considerable extra risk premium, it is difficult to see how the value of an IUU investment (i.e., the maximum C_0) can be very much lower than that of a similar investment in a legal fishery.

19. Let us assume, for the sake of argument, that expected net operating profits in an IUU fishery are at least as high as they would be in an alternative legal fishery, and that the investment is evaluated over the same timescale. Assume also that the "normal" risks associated with fishing are similar, but that in the IUU fishery there is an "excess" risk premium R_E which stems from the perceived likelihood of one or more costly enforcement events over the investment timescale. Then we can write an expression for the value (the investor's maximum WTP) for a given amount of capacity *K* in an IUU fishery, which we will denote C_0^I, as

$$C_0^I = \sum_{t=1}^{T} \rho^t \overline{\pi}_t(K) + \rho^T C_T^I - R - R_E. \quad (6)$$

20. Further, assume that in the absence of any intervention by the authorities, the present value of the depreciated capacity at time *T* would be the same whether the capacity is used in legal or illegal fishing. Now we can write

$$C_0^I = \left[\sum_{t=1}^{T} \rho^t \overline{\pi}_t(K) + \rho^T C_T - R \right] - R_E$$

which from (5) is simply

$$C_0^I = C_0^L - R_E, \quad (7)$$

where C_0^L is the value of the same capacity in a legal fishery. Thus the maximum WTP for equivalent capacity in an IUU fishery is given by the WTP for a similar investment in a legal fishery, less the excess risk premium imposed due to enforcement activities.

4. Overcapacity in EEZs and investment in IUU fishing

21. In many regulated EEZ fisheries, the nature of the past management regime has allowed excess capacity to develop, in the sense referred to in the Introduction. Although, in the short run, the impact of this excess capacity may be an increase in catches above the limits set by managers (given that in most regimes enforcement is considerably less than perfect and the allocation of fishing rights is often highly inflexible), sooner or later we would expect profitability in the fishery to decrease as the stock is depleted (see, for example, Munro and Clark 2003). The problem of excess capacity is exacerbated to the extent that fishing capacity (capital) is *non-malleable* (see Clark, Clarke and Munro 1979).[6] If existing capacity has a low resale value, the opportunity cost of remaining in the fishery is reduced and voluntary disinvestment is less likely to take place in the short run, even if current operating profits are low. This means that Government intervention is almost certainly required if a significant immediate reduction in capacity is to be achieved (see Appendix B). As noted earlier, it is often suggested that the subsidised removal of excess capacity in this way from regulated fisheries is responsible for a "spillover" of cheap capacity into IUU fisheries and that this may be a significant driver for IUU fishing (e.g., Bray 2000, p.12, Agnew and Barnes 2004, p.20).[7]

22. Let us examine this suggestion. Recall that in a perfect market for fishing capacity, the equilibrium cost of capacity will equate the opportunity cost of capacity for incumbents (those who have already invested in the fishery) with the cost of the same capacity to new investors. It follows that if the opportunity cost for incumbents in a regulated fishery is low, this must necessarily be linked to *low* expected returns in alternative uses for that capacity, i.e., use in other fisheries (otherwise, any excess capacity could obviously be sold outwith the fishery at a higher price). This may well be the case for alternative *legal* fisheries, which in general may be taken as operating at full capacity (and "new" fisheries, such as those for previously unexploited species, are relatively few and may require new capacity of a quite different technical specification). However, the existence of investment opportunities in IUU fishing, if profitable, would tend to support rather high vessel resale values. If this does not happen, and if IUU fishing is potentially profitable as we have suggested, it could be because the "supply" of potential investors in IUU fishing is greatly exceeded by the supply of secondhand capacity at any given price.[8] Thus IUU investors represent a "thin" market for capacity and collectively take the price of capacity as given (i.e., the demand for capacity from IUU investors has little or no effect on the resale price of capacity, which is determined exogenously). Another (though not exclusive) explanation could be that there exist barriers to trade in vessels between legal fisheries and IUU investors which result in significant transaction costs.[9]

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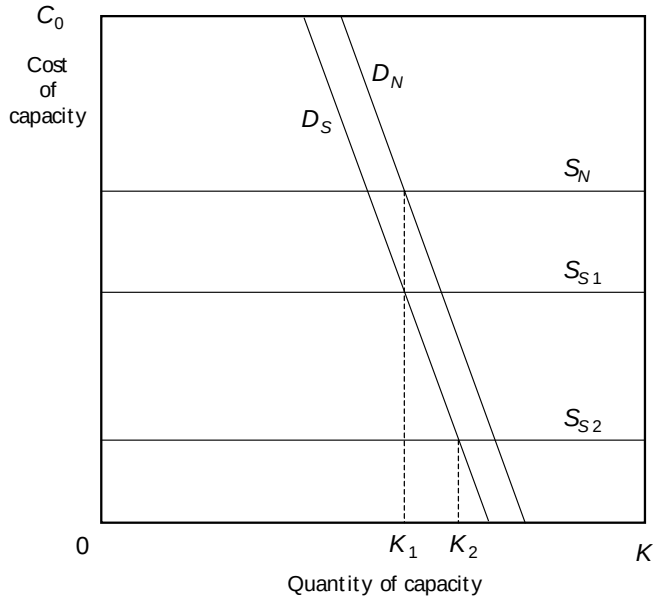
[6] Capital is non-malleable if it has few (or no) alternative uses and hence a very low resale value (possibly only the scrap value). The result is that capital is treated as a *sunk cost* and the opportunity cost of remaining in the fishery is therefore significantly lowered, comprising little more than the present value of expected future operating profits.

[7] For a simple explanation of the operation of a spillover effect in fisheries see Munro and Clark (2003).

[8] It may be that relatively few investors are willing to engage in illegal fishing because of normative beliefs against illegal activity or a high degree of risk aversion.

[9] The alternative explanation would be that demand from potential IUU investors does determine the resale price of capacity, but that either expected returns in IUU fishing are inherently low, or the risk from enforcement

Figure 1. The demand for capacity in IUU fishing at different supply prices



23. Consider the situation depicted in Figure 1. Here, the demand for an amount of capacity K in IUU fishing at a cost C_0 is indicated by D_N in the case of new capacity and D_S in the case of secondhand capacity. The WTP for secondhand capacity is lower than for new capacity, but in both cases demand over the relevant price range is relatively *price inelastic*, reflecting a generally high WTP for investments in IUU fishing so that low capacity prices are not necessary to attract most of the potential investment. Equivalently, most of the demand for IUU capacity would be satisfied at relatively high capacity prices. Suppose that, to begin with, the supply price for new capacity (i.e., new vessels ordered directly from boatyards) is given by S_N while the price of secondhand capacity (in some unspecified market) is given by S_{S1}. For simplicity, it is assumed that whether new or secondhand capacity is purchased the resulting level of capacity in the IUU fishery is the same at K_1.

24. Now let a supply of "cheap" capacity S_{S2} become available as a result of the subsidised removal of excess capacity from a regulated fishery. Although the price of secondhand capacity is now considerably reduced, the total level of capacity in the IUU fishery only increases by a

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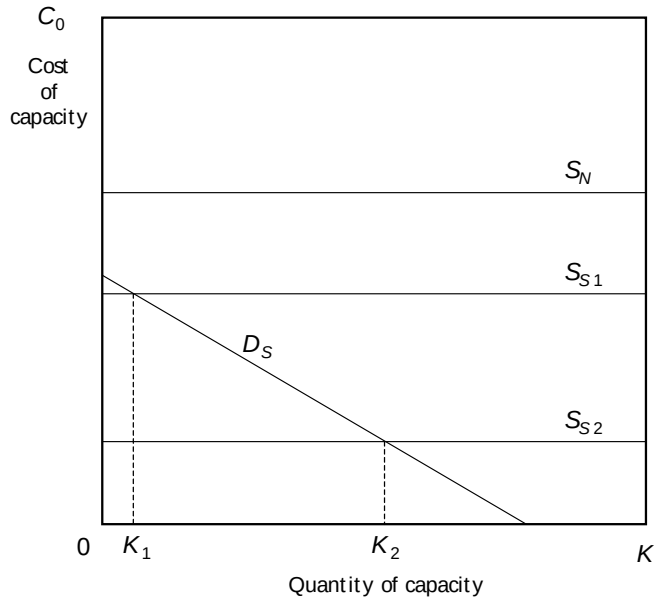
activities (and hence R_E) is sufficiently high that the WTP for investment in IUU fishing is significantly reduced.

relatively small amount, to K_2. If IUU fishing is profitable, as depicted in Figure 1, it would be hard to argue that the main driver for the level of IUU capacity is the availability of cheap capacity spilling over from a regulated fishery. Rather, the main effect of the cheap capacity is to deliver a "windfall" gain to the majority of investors in IUU fishing who would have invested in any case, but at a higher cost.

25. Now suppose that IUU operations are very marginal, i.e. expected returns are sufficiently low that the availability of cheap capacity *is* the main driver for investments in IUU fishing. The situation would now look more like that depicted in Figure 2. Little or no new capacity is invested in IUU fishing, while given a "normal" supply of secondhand capacity S_{S1}, only a relatively low level of capacity K_1 enters the IUU fishery. The availability of cheap capacity at S_{S2} now makes a significant difference, increasing the level of IUU fishing capacity from K_1 to K_2.

Figure 2. The demand for IUU capacity when IUU operations are marginal



26. Clearly, the alternative scenarios depicted in Figures 1 and 2 are hypothetical, but they serve to illustrate the following proposition. If IUU fishing *is* relatively profitable, then the use of secondhand capacity disposed of cheaply from regulated fisheries is largely opportunistic on the part of IUU investors and cutting off this supply of capacity would merely divert much of the

demand to more costly secondhand capacity or even to new capacity.[10] Only if IUU fishing operates at a very low level of profitability would we expect the main driver for IUU investments to be the availability of cheap capacity and should we therefore be particularly concerned about the disposal of excess capacity from regulated fisheries.

27. Earlier in this paper it was suggested that it is in the absence of effective management that, in policy terms, we need to be concerned about the market supply of production factors employed in fishing. The implication here is, of course, that IUU fishing is problematic because current enforcement capabilities are inadequate to deter IUU activities. Further, if IUU fishing is relatively profitable, then to make it less profitable requires that enforcement activities are sufficient to impose very significant additional expected costs. In equation (7) we set out the simple rule

$$C_0^I = C_0^L - R_E,$$

which implies that, in order to make the value of an IUU investment significantly lower than the value of an equivalent investment in a legal fishery, we need to raise the value of R_E considerably. Given $C_0^I << C_0^L$, we might then be in a position (as depicted in Figure 2) where the spillover of cheap capacity from regulated fisheries could be an important driver for IUU fishing.[11]

5. Conclusion

28. Available evidence (as reviewed in Agnew and Barnes 2004) suggests that IUU fishing is relatively profitable rather than being of only very marginal profitability. If this is the case, then any spillover of cheap capacity from capacity reduction programmes in regulated fisheries will certainly deliver benefits to IUU operations, but it is unlikely to be the main driver for the level of capacity invested in IUU fishing. However difficult it may be to achieve in practice, the conclusion is that expected returns from IUU fishing must be reduced to the point where investment in capacity for use in IUU fisheries is no longer perceived as profitable. This could be achieved, for example, by a greatly enhanced probability of costly sanctions for engaging in IUU activities, although alternative approaches such as denying IUU vessels access to output markets would, if successful, also reduce the profitability of IUU fishing very considerably. Either approach requires a great deal of enforcement effort, which is costly to society. There is an inevitable trade-off to be made between increasing the social cost of enforcement and reducing the social cost of IUU fishing. As proposed above, it is only if expected returns in IUU fishing are

[10] According to Agnew and Barnes (2004, p.20) there is evidence that new vessels are being built for the illegal longline fishery for toothfish.

[11] As an interesting but extreme case, suppose that there is a very high expectation of vessel confiscation on an annual basis (so that $R_E = \rho^T C_T$ where $T = 1$ and hence $C_0^I = \rho\overline{\pi}_1(K) - R$). Now capacity is treated as an annual operating cost and clearly we must have $S_S << C_0^L$ if IUU fishing is to remain viable.

very low that we should be concerned about the spillover of cheap capacity from regulated fisheries and hence the need to prevent resale of decommissioned capacity at low prices.[12]

[12] Unfortunately, intervening in markets can often have undesirable as well as desired consequences. The availability of cheap capacity to legitimate and well-managed fisheries in less developed countries, for example, would be considered a good, but would be cut off by any policy to deny such gains to IUU vessels.

APPENDIX A

Extract from the *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO 2001):*

3. In this document

3.1 Illegal fishing refers to activities

3.1.1 conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations;

3.1.2 conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or

3.1.3 in violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization.

3.2 Unreported fishing refers to fishing activities

3.2.1 which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or

3.2.2 undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization.

3.3 Unregulated fishing refers to fishing activities

3.3.1 in the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization; or

3.3.2 in areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

3.4 Notwithstanding paragraph 3.3, certain unregulated fishing may take place in a manner which is not in violation of applicable international law, and may not require the application of measures envisaged under the International Plan of Action (IPOA).

APPENDIX B

Capacity adjustment and "buyback" schemes

Given the policy decision to reduce the level of capacity in a fishery, fishing vessels could then simply be decommissioned without compensation. However, natural justice and political realities generally dictate some form of buyback scheme, usually on a voluntary basis. Under most such schemes, fishermen are invited to bid for funds in return for relinquishing the right to fish with their existing vessel. Bids are then selected according to some chosen "value for money" criterion, but this can be problematic. For example, the opportunity cost of remaining in the fishery is lower for the more unprofitable vessels and hence these are more likely to take advantage of a voluntary decommissioning scheme. Since higher levels of fishing mortality are likely to be exerted by the more profitable vessels, however, this poses a problem for managers seeking to reduce overall levels of fishing mortality while at the same time, presumably, wishing to see overall fleet profitability increase rather than decrease (see, for example, Walden, Kirkley and Kitts 2003). More generally, buyback schemes have been criticised for being costly, being relatively ineffective in practice and rarely dealing with the underlying causes of overcapacity (e.g., Hatcher 1999, Holland, Gudmundsson and Gates 1999).

Buyback schemes vary in their rules for the disposal of redundant capacity. Under the EU's Common Fisheries Policy, for example, a series of "Multi-annual Guidance Programmes" (MAGPs) have, for the last twenty years or so, provided for national buyback schemes within a framework of Community rules and funding (see Hatcher 2000). Community rules have allowed vessels for which fishing rights have been relinquished to be disposed of either by scrapping, permanent transfer to a third country or permanent reassignment to non-fishing use, although Member States could determine more restrictive terms of disposal if they wished. In the UK, for instance, decommissioning rules have always required scrapping (see Pascoe, Tingley and Mardle 2002). Recently, however, Community rules have been changed to remove the possibility of transfer to a third country, with effect from January 2005.[13] According to the European Commission's *Explanatory Memorandum* for the proposed amendment to the relevant Regulation, the existing rules "only result in a transfer of Community over-capacity to third countries and do not correspond to a reasonable use of European tax-payers' money".[14]

[13] Council Regulation (EC) No 2369/2002 of 20 December 2002 amending Regulation (EC) No 2792/1999 laying down the detailed rules and arrangements regarding structural assistance in the fisheries sector. *Official Journal of the European Communities*, L358, 31.12.2002, p.49-56.

[14] Commission of the European Communities, COM(2002) 187 final, Brussels, 28.5.2002, p.3.

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