Chapter 2: Making and Taking

... it is lamentable to think how great a proportion of all the efforts and talents in the world are employed in merely neutralizing one another. It is the proper end of government to reduce this wretched waste to the smallest possible amount, by taking such measures as shall cause the energies now spent by mankind in injuring one another, or in protecting themselves against injury, to be turned to the legitimate employment of the human faculties, that of compelling the powers of nature to be more and more subservient to physical and moral good.

John Stuart Mill, 1848

... considering that the state of man can never be without some incommodity or other; and that the greatest, that in any form of government can possibly happen to the people in general, is scarce sensible in respect of the miseries, and horrible calamities, that accompany a civil war, or that dissolute condition of masterless men, without subjugation to laws, and coercive powers to tie their hands from rapine and revenge; nor considering that the greatest pressure of sovereign governors, proceedeth not from any delight, or profit they can expect in damage or weakening of their subjects, but in whose vigour, consisteth their own strength and glory.

Thomas Hobbes, *Leviathan*, 1651

“Do unto others”, says the moralist, “as you would have them do unto you.” The saying would be meaningless, unless it is supposed that you might prefer to do otherwise. To act morally is - almost by definition - to choose what is right over what is best for oneself alone. The central proposition in economics - a proposition that repetition has rendered less astonishing than it should be or than it is when encountered for the first time - is that the presumed gap between what is best for oneself and what is best for everybody is sometimes illusory.

“Do as you please” says the economist “because you serve others best when you serve yourself alone.” Economics is about when and under what circumstances this is so. Economics is about how the combined effect of self-interested behaviour by all of the participants in the economy is very often conducive to the common good in some sense of the term. Economics is the calculus of greed, designed in part to show when greed can be harnessed to the common good and in part to work out the less-obvious implications of self-interested behaviour. We begin in this chapter with a simple example in which one’s first thought about the matter turns out to be correct because everybody becomes significantly worse off doing what they please than if their activities were coordinated. This book is mostly about circumstances where the “invisible hand” of the competitive market - referred to in the quotation from Adam Smith at the beginning of the preface - works in the service of the common good. This chapter is about circumstances where that is not so. Here the invisible hand is perverse and needs to be constrained.

The Story of the Fishermen and the Pirates

Along the Canadian-American border is a region called the Thousand Islands where Lake Ontario drains into the St. Lawrence River. Fishing is good in the Thousand Islands. As one might imagine, there are many fishing spots concealed by the islands from one another. This is the location of our example: not the actual Thousand Islands, but an abstract and theoretical Thousand Islands isolated from the rest of the world and populated by folk who may choose to be fishermen or to be pirates. The following assumptions describe the place completely.

(a) There are N people each free to choose between two occupations, fishing and piracy.

(b) There are L fishing locations. Every day, fishermen select locations at random, spreading themselves out so that there is never more than one fisherman at each location. There are more than enough locations to go round, even if everybody became a fisherman, i.e. $L > N$.

(c) Every fisherman catches one ton of fish per day. There is no scarcity of fish, no risk of depletion of the stock and no problem of conservation. If everybody chose to be a fisherman, the national income per day would be N tons of fish.

(d) Pirates prey on fishermen and take away their fish. Pirates do not know where the fishermen are located, and they have just time to search S locations looking for fishermen. If, on any search, a pirate discovers a fisherman he appropriates the entire catch. Otherwise the search is wasted. On a very lucky day, a pirate finds a fisherman on every search, and his income that day becomes S tons of fish. Normally, a pirate is less successful because some of the locations he visits are unoccupied by fisherman or because occupied locations are visited by other pirates as well. If more than one pirate preys on a fisherman, the pirates divide the catch equally among themselves. Think of fishermen as embarking for the fishing grounds early each morning and of pirates as venturing out later in the day after the catch is in but before the fishermen have time to return to the safety of the port. Assume for simplicity that pirates do not learn from their mistakes. Every search is at a location drawn randomly from the L available locations. Pirates never prey on one another.

(e) Everybody is equally skilled at fishing and piracy, and both occupations are equally arduous. As this is economics, there are no moral scruples in the choice of a profession. People choose to be fishermen or pirates to acquire the largest possible tonnage of fish. They sort themselves out as fishermen or as pirates until it is no longer beneficial for anybody to change from one occupation to the other. There is some uncertainty in each occupation, but people ignore risk because the largest expected income each day provides the best living in the long run.

(f) There are no police to maintain order and protect the fishermen's catch.

In these assumptions, realism is sacrificed to simplicity to focus as clearly as possible on the nature of an anarchic society. Unrealistic features and possible modifications of these assumptions will be discussed presently after the formal model and a numerical example are presented.

The moral of the story is simple but important. People choose between fishing and piracy just as they might choose between two legitimate occupations such as law and medicine. They sort themselves out as pirates or fishermen until it would be disadvantageous for anybody to change professions. If the income of fishermen exceeded the income of pirates, some pirates would become fishermen instead, lowering the income of fishermen and raising the income of pirates until the equality between their incomes is restored. Similarly, if the income of pirates exceeded the income of fishermen, some fishermen would become pirates instead, lowering the income of pirates and raising the income of fishermen until the equality between their incomes is restored. The determination of incomes is the same as in any other labour market where people are equally competent in all occupations. Yet piracy is obviously harmful not just to the fishermen on whom the pirates prey but to the pirates themselves, for everybody's income is lower than if piracy could somehow be prohibited. Self-interest drives some people to become pirates even though everybody, those who become pirates as well as those who become fishermen, would be better off if piracy could somehow be prohibited.

Three sorts of outcomes are possible, depending on the parameters of the model: There may be no piracy because fishing is the more lucrative occupation no matter how many or how few pirates there happen to be. That would be so if there were so many more locations than people that a pirate had too little chance of discovering a fisherman in the limited number of searches he is able to make. This possibility is uninteresting in the present context because it fails to illustrate the problem that this chapter is about.

There may be no fishing. For that to be so, piracy must remain more lucrative than fishing no matter how many pirates or how few fishermen there turn out to be. Were that so, everybody would become a pirate, and no fish would be caught. Society would destroy itself in an orgy of predation, or population would fall enough, and the ratio of fishing sites to people would rise enough, that it is in the interest of some people to become fishermen again.

There may be some piracy and some fishing. Piracy may be more lucrative than fishing as long as pirates constitute less than a certain fraction of the population, but less lucrative when the proportion of pirates becomes too large. We shall now show how the "equilibrium" number of pirates - the number such that no pirate would be better off switching to fishing, and no fisherman would be better off switching to piracy - can be determined from information about total population, N, the number of locations, L, and the number of searches per pirate, S.

Piracy must necessarily reduce the average income per head of fishermen and pirates together. With no pirates at all, the income per head would be one ton of fish per person. With m pirates, the average income per head must fall to $(N - m)/N$ tons of fish because a total catch of N - m tons must somehow be apportioned among N people.

Denote the expected incomes of fishermen and pirates as y_f and y_p respectively. Total income must, one way or another, equal the total catch, that is,

$$(N - m)\, y_f + m\, y_p = N - m \qquad (1)$$

or, equivalently,

$$[(N - m)/N]\, y_f + [m/N]\, y_p = (N - m)/N \qquad (2)$$

where $(N - m)/N$ is at once the proportion of fishermen in the population and the average income per head in both occupations, and where m/N is the proportion of pirates in the population. Equation (2) shows average income per head as a population-weighted average of income per head of fishermen and income per head of pirates.

Suppose, for example, that there are 10 people and 20 locations and that each pirate can investigate 4 locations. If everybody were a fisherman, the total catch would be ten tons of fish or one ton per head. If one person became a pirate instead, the total catch must be reduced from 10 to 9 tons and the average income of fishermen and pirates together falls to 9/10 of a ton. It is, nevertheless, in the interest of at least one person to become a pirate because, as will be demonstrated below, the income of one pirate among nine fishermen would well above one ton of fish, and it is no concern to him that others' incomes are reduced by more than his is increased. Each person reasons that if I do not become a pirate somebody else will, and I shall be that much worse off remaining as a fisherman. A second pirate causes average income to fall to 8/10 of a ton, a third to 7/10 and so on.

To discover the number of pirates (m) for a given population (N), number of fishing locations (L) and searches per pirate (S), we first show how the incomes of fishermen and pirates (y_f and y_p) depend on the number of pirates (m), and we then deduce the number of pirates for which these incomes are equal. In other words, for given values of L, N and S, we wish to construct functions $y_f(m)$ and $y_p(m)$ which can be equated to determine the value of m that emerges when everybody is free to choose between fishing and piracy and each person chooses between occupations to make himself as well off as possible.

For any given number, m, of pirates, there must be N - m fishermen who occupy a randomly chosen N - m of the L available locations. The pirates search among the L locations hoping to find a fisherman. On each of his S searches, a pirate has a probability 1/L of arriving at any given location, so that his probability of missing that location is (1 - 1/L). Recall the general principle that, when the probabilities of two events are independent, the probability of both occurring at once is the product of the probabilities of the two events. From this principle, it follows at once that a pirate's probability of missing any given location in all S of his searches is $(1 - 1/L)^S$ and that the probability of a given location being missed by all m pirates is $(1 - 1/L)^{mS}$. Since each fisherman catches one ton of fish, his net expected income - his catch reduced by the expected "tax" imposed by pirates - is exactly equal to the probability that no pirate succeeds in finding him. Thus, for any given L, S, the expected income of a fisherman as a function of the number of pirates, m, becomes

$$y_f(m) = (1 - 1/L)^{mS} \qquad (3)$$

which is the probability that no pirate appears at the fisherman's location.

Suppose there are 20 locations, 3 pirates, and 4 searches per pirate. The probability that any given pirate visits any given location on any given search is 1 in 20 or 5%. The probability of his missing that location on that search is 95%. The probability of his missing that location in all four of his searches is $(0.95)^4$ or 81.45% The probability of 3 pirates missing that location altogether is $(0.95)^{4x3}$ or 54.04%. With a probability of about 54% of retaining his catch, the fisherman's expected net income has to be about 0.54 tons per day, down from 1 ton in the absence of piracy.

To determine the expected income of a pirate, note that, when the fisherman bears a probability $(1 - 1/L)^{mS}$ of retaining his catch, the corresponding probability of losing his catch to pirates must be $1 - (1 - 1/L)^{mS}$. Since the fisherman's probability of losing his catch must equal the pirates' share of the catch, and since there are N - m fishermen, the total loot of all pirates together must be $(N - m)[1 - (1 - 1/L)^{mS}]$, and each pirate's expected income, $y_p(m)$, must be

$$y_p(m) = [(N-m)/m][1 - (1 - 1/L)^{mS}] \quad (4)$$

A pirate's expected income is total expected loot in the economy - the average loot per fisherman multiplied by the number of fishermen - divided by the number of pirates.

How many pirates will there be? The equilibrium number of pirates, denoted by m*, is the number at which every person - fishermen and pirates alike - is content with his choice of occupation. The determination of m* depends on whether it is constrained to be an integer. To confine m* to integers is to say that both occupations must be full time. To relax that assumption is to say that m* might be a number such as 3.27, indicating that three people work full time at piracy and a fourth person devotes 27% of his time to piracy and the remaining 63% to fishing. With m* not confined to an integer, people sort themselves between occupations to equalize incomes exactly. The labour market induces a value of m* such that

$$y_f(m^*) = y_p(m^*) \quad (5)$$

and where $y_f(m)$ and $y_p(m)$ are defined in equations (3) and (4). Together, the three equations - (3), (4) and (5) - would determine the three unknowns $y_f(m^*)$, $y_p(m^*)$ and m*.

Equation (5) cannot hold exactly when, as we have assumed, each person must apply himself full-time to either fishing or piracy. To generalize equation (5) for a market with a finite population, N, and where each person must choose one of the two occupations, think of people as "originally" fishermen and as switching to piracy one by one as long as it is profitable to do so. There would be no piracy at all if N were small enough that

$$y_p(1) < y_f(0) = 1 \quad (6)$$

for a fisherman could only make himself worse off by switching to piracy. With N in excess of the minimal value for which this inequality holds, the income of the first person to switch from fishing to piracy exceeds the income of the fishermen when there are no pirates. Some fisherman switches from fishing to piracy because $y_p(1) > y_f(0)$. The second switch occurs if $y_p(2) > y_f(1)$. More and more fishermen turn to piracy until the time comes when it is no longer profitable to do so. There is finally a number of pirates, m*, for which it is no longer true that $y_p(m^* + 1) > y_f(m^*)$. Thus, the number of pirates for which everybody is content with his present occupation is m* defined by the condition that

$$y_p(m^*) > y_f(m^* - 1) \text{ and } y_p(m^* + 1) < y_f(m^*) \qquad (7)$$

With fewer than m* pirates, the second inequality is reversed; with more than m* pirates, the first inequality is reversed. Think of equation (7) as the natural extension of equation (5) when m is discrete. Note that, at the equilibrium where nobody wants to change occupations, a pirate is still slightly better off than a fisherman, but not so much better off as to outweigh the fall in the income of pirates brought about by one extra person's switch to piracy. The values of $y_p(m^*)$, $y_f(m^*)$ and m* can be computed from equations (3), (4), and (7).

The story is told by numerical example in table 1 for a society with 10 people, 20 fishing locations and 4 searches per pirate. The expected income of fishermen, the expected income of pirates and average expected income per person are shown for all possible numbers of pirates from 0 to 10. The first column shows m. The next shows y_f calculated from equation (3). The next shows y_p calculated from equation (4). The final column shows average expected income per head of fishermen and pirates together.

The first row of the table shows what happens when everybody is a fisherman and there are no pirates. The fisherman keeps his entire catch, and his income is one ton of fish. The second row shows what happens after one person switches from fishing to piracy. With nine rather than ten fishermen, the total catch must be reduced from 10 to 9 tons per day and the average income per person must fall from 1 ton to 0.9 tons as shown in the final column of the table. Since each pirate makes 4 searches, each of the nine remaining fishermen is now subjected to four chances of losing his catch with a probability of 5%, reducing his expected income to $(0.95)^4 = 0.8145$. The corresponding income of the one pirate has to be the difference between the total catch, 9, and the sum of the expected incomes of the fishermen, (9×0.8145). The pirate's income becomes 1.6696 [that is $9 - (9 \times 0.8145)$] as shown in the third column, indicating that it would be personally advantageous for one of the original ten fishermen to switch to piracy even though the average income of all ten people is reduced. All other rows are constructed accordingly. Note that the income of the fisherman in the last row cannot be the income of actual fishermen because there are none. It is the income of an eleventh person if there were one and if he chose to be a fisherman.

Table 1: How the Income of Fishermen, the Income of Pirates, and the Average Income per Head Depend on the Number of Pirates

[There are 10 people and 20 fishing locations. Each pirate can investigate 4 locations]

Number of Pirates (m)	Income of Fishermen (y_f, tons per head)	Income of Pirates (y_p, tons per head)	Average Income per Head (N- m)/N
0	1	-	1
1	0.8145	1.6695	0.9
2	0.6634	1.3464	0.8
3	0.5403	1.0725	0.7
4	0.4401	0.8399	0.6
5	0.3585	0.6415	0.5
6	0.2920	0.4720	0.4
7*	0.2378	0.3267	0.3
8	0.1937	0.2016	0.2
9	0.1578	0.0936	0.1
10	0.1285	0	0

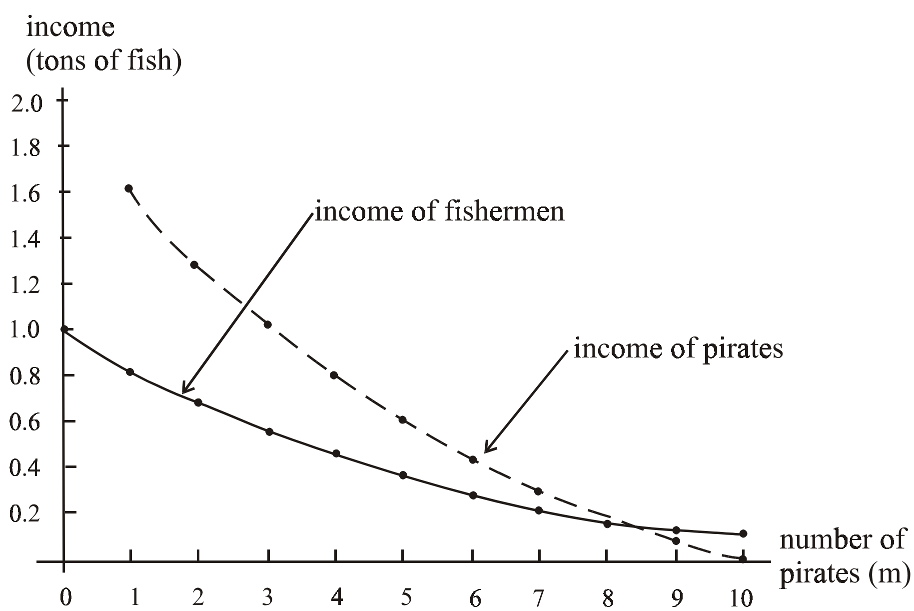
Note: a) Incomes of fishermen and pirates are computed for each value of m in accordance with equations (3) and (4). b) In accordance with equation (7), each person is content with his choice of occupation when there are 7 and 3 fishermen, that is, $y_p(7) > y_f(6)$ but $y_p(8) < y_f(7)$.

The outcome in table 1 is that seven out of ten people become pirates, reducing average expected income per head by two-thirds, from 1 ton of fish if piracy were somehow prohibited to 0.3 tons of fish when each person chooses in his own best interest whether to be a fisherman or a pirate. With less than seven pirates, it is in each fisherman's interest to become a pirate instead, even though his switch from fishing to piracy lowers the average income in the population as a whole. When there are only six pirates, a fisherman can increase his income from 0.2920 to 0.3267 by becoming a pirate, and he does so. Only with seven or more pirates does the switch become unprofitable. When there are seven pirates, each of the three remaining fishermen would reduce his income from 0.2378 to 0.2016 by becoming a pirate, and he chooses not to do so.

The harm is not just that pirates gain at the expense of fishermen. It is that everybody's expected income - fishermen and pirates alike - is less than it would be in a world without piracy. With no piracy, everybody would acquire 1 ton of fish. With seven pirates, every fisherman acquires 0.2378 tons and every pirate acquires 0.3267 tons, but no additional fisherman switches to piracy because the switch would reduce his income from 0.2378 tons to 0.2016 tons. However, since the pirates' income exceeds the fishermen's income, there is an advantage to the seven people who become pirates first.

The story in table 1 is retold in figure 1 with incomes on the vertical axis and numbers of pirates on the horizontal axis. For all values of m, the expected incomes of fishermen from column 2 of table 1 are shown as dots connected by a solid line, and expected incomes of pirates are shown by dots connected by a broken line. Two important features of the story are brought out when the data are graphed. First, it is immediately evident that the income of the pirates starts above the income of the fishermen when m = 1, and then declines more steeply, becoming the same for some m between 0 and 10. If the income of the pirates did not start above the income of the fishermen, there would be no piracy. If the incomes of pirates did not decline more steeply than the incomes of fishermen, society would destroy itself. As mentioned above, both situations are possible. The former is uninteresting because no predation would ever be observed. The latter is unrealistic because the parameters of the problem would have to change.

Figure 1: Incomes of Fishermen and Pirates Depending on the Number of Pirates



Second, the joining of the dots shows incomes of fishermen and pirates as continuous functions of the number of pirates with a crossing of the curves where the incomes are equal. The smooth curve is representative of more realistic situations where m is, in actuality or for all practical purposes, a continuous variable. The number of pirates would become a continuous variable if the model were reconstructed so that people could choose how many hours in the day to devote to fishing and how many hours in the day to devote to piracy. In that case, the horizontal axis of the graph would become the proportion of total available hours devoted to piracy, and equation (7) would automatically collapse into equation (5) yielding a unique market-determined income per hour for everybody, fishermen and pirates alike. A similar outcome would emerge in a large market with a great many fishermen and a great many pirates. A small population was postulated for simplicity of exposition and to tell a story that (we hope) is intuitively appealing.

An interesting feature of the fishermen and pirates story is that population growth leads to a decline in output per head, even in circumstances where there would be no such decline in the absence of piracy. This is not the much-told tale of population growth leading to impoverishment as more and more people draw upon a given endowment of resources. That path to impoverishment will be examined in Chapter 6. It is not the mechanism here because, together, assumptions (b) and (c) guarantee that each fisherman catches one ton of fish per day regardless of the population, as long as there remain more fishing locations than there are fishermen to occupy them. In the absence of piracy and as long as $L > N$, output per head would be unaffected by an increase in population.

The introduction of piracy changes the story completely. When m people out of a total population of N choose to become pirates, the output per head falls from 1 to $(N - m)/N$. If total population grew but the number of pirates remained unchanged at m, there would have to be an increase in output per head because $(N - m)/N$ is an increasing function of N. But m does not remain unchanged. On the contrary, by increasing the pirates' chance of discovering a fisherman at any given location, an increase in population creates such a large increase in the profitability of piracy that the number of people choosing to become pirates increases more than proportionally with population. The proportion of pirates increases, the proportion of fishermen falls, and the income per head falls accordingly, for the ratio $(N - m)/N$ is at once the proportion of fishermen and the output of fish per head .

To see why an increase in N leads to a fall in $(N - m)/N$, suppose first that N increases but m remains the same. Were that so, the income of fishermen, as shown in equation (3), would remain the same also, but the income of pirates, as shown in equation (4), would increase because $(N - m)/m$ would increase while $[1 - (1 - 1/L)^{mS}]$ remains unchanged. A gap would emerge between the incomes of pirates and fishermen, causing some fishermen to become pirates instead.

For average income to fall, the number of pirates at which everyone is content with his choice of occupation must increase more than proportionally with population. The ratio $(N - m)/N$ would have to be reduced. That must turn out to be so because even proportional increases in m and N would not be sufficient to maintain the equality between the incomes of fishermen and pirates in equations (3) and (4). With equal proportional increases in N and in m*, the term $(N - m)/m$ in equation (4) must remain unchanged. But the increase in m must lower $(1 - 1/L)^{mS}$ in equation (3) and raise $(1 - (1 - 1/L)^{mS})$ in equation (4) accordingly, so that y_f falls and y_p rises, causing m to increase still further if the equality between y_f and y_p is to be maintained. Thus, the larger the population, the larger the proportion of pirates, and the smaller the common income per head.

This proposition is illustrated in table 2 for a fishermen and pirates economy where, once again, the number of fishing spots, L, equals 20 and the number of searches per pirate, S, equals 4. The first column shows total population, the second shows the number of pirates computed by trial and error from equations (3), (4) and (7), the third shows the income of fishermen, the fourth shows the income of pirates and the final column shows average income per head in the entire population. It is easy for the reader to check that the numbers in the table are what they are claimed to be. Outcomes are compared for seven populations: less than 7, 7, 8, 9, 10, 11 and 12. All populations less than 7 can be considered together because 7 turns out to be the smallest population for which there are any pirates at all. With a population of less than 7, there is no piracy, and the fisherman keeps his entire catch of fish.

Table 2: How the Number of Pirates Increases by More than the Increase in Population, and How the Average Income per Person Declines Accordingly

Population (N)	Number of Pirates, (m*)	Income of Fishermen, $y_f(m^*)$	Income of Pirates, $y_p(m^*)$	Average Income, (N - m*)/N
less than 7	0	1	-	1
7	1	0.6634	0.8415	0.8571
8	4	0.4410	0.5599	0.5000
9	5	0.3585	0.5132	0.4444
10	7	0.2378	0.3267	0.3000
11	8	0.1935	0.3024	0.2727
12	10	0.1285	0.1743	0.1667

Three important propositions are illustrated in table 2: First, for any given number of fishing locations, there is a minimal population below which piracy does not pay at all. Second, the increase in the number of pirates is more than proportional to the increase in total population. Third, average income per head declines substantially as the population grows. In the numerical example, the decline in income per head is from 1 ton to 1/12 tons as population increases from 6 to 12. Population growth decreases average income per head by increasing the proportion of pirates in the population for which the incomes of fishermen and pirates are equalized.

The tale of the fishermen and the pirates is about a discrepancy between private interests and the common good. This is the simplest tale one can tell of how it is in nobody's immediate interest to cooperate even though everybody would become better off with universal cooperation than when each person does what is best for himself with the means at hand. Hardly a surprising state of affairs, but one that needs emphasis at the outset of a course in economics where other, very different, tales will be told about how the combined effect of each person doing what is best for himself is in some sense the best for everybody. The essence of the fishermen and pirates example that, though everybody - fishermen and pirates alike - would be better off under a binding agreement to desist from piracy, it would be in each person's interest to break the agreement, making himself better off at the expense of the rest of the community. Public enforcement is required if such agreements are to be honored at all.

The story has been told as simply as possible. The six explicit assumptions set out above are chosen to focus upon the gap between private interest and the common good, with as little extraneous material as possible. But the assumptions are much stronger and less representative of real social conflict than one might at first suppose. Behind the explicit assumption are several implicit assumptions that should be identified to clarify the example and as pointers to considerations that might be introduced in more realistic depictions of social interaction.

(1) There is no geography. The story may appear to have a geographical dimension because fishermen occupy different locations, but the geography is spurious. Locations cannot be mapped and it cannot be said within the context of the story that place A is closer to place B than to place C, or that you have to pass through place B to get from place A to place C. There is no distance or proximity. This feature of the story should be emphasized because it characterizes most of the literature of economics, even the literature on international trade. It is perhaps remarkable how useful economics can be in spite of this restriction. There are instances where geography is explicitly introduced into economic analysis, but these are rare.

(2) There is no time. While it is true that the interaction between fishermen and pirates and pirates is said to take place in the course of a day, the model is *atemporal* in the sense that the economy is assumed to replicate itself over and over again forever. Nothing ever changes, not, at least, on the assumptions we have made so far. But, in this model as in many other economic models, the atemporal assumption is not fundamental. A rudimentary dynamics is introduced in the study of production in chapter 6. A thorough analysis of how societies change over time is beyond the scope of this book.

(3) There is an exceedingly restrictive model of production. Assumption (c) above - every fisherman catches one ton of fish, no matter how few or how many fishermen there are - implies that

$$F = n \tag{8}$$

where F is the total catch of fish in tons and n is the number of fishermen (equal to N - m). The relation between input and output in equation is the simplest imaginable example of a *production function*, the general form of which (within the fishing example) is

$$F = g(n) \tag{9}$$

where g is any increasing function of n. The production function, g, is often assumed to be *concave*. Output, F, is assumed to increase with input, n, but at a decreasing rate, so that each additional unit of n yields a progressively smaller addition to F. Concavity would be a reasonable assumption if, for example, F stood for food grown rather than fish and n stood for the number of farmers producing that food on a given plot of land. Concave production functions will be employed in chapter 6 to explore whether and in what circumstances population growth leads to the impoverishment of mankind. Assumption (c) is that the production function for fishing is *not* concave as long as $N < L$.

(4) There is no trade. The model looks no further than the production of fish. Trade of one good for another and the emergence of market-determined prices are put aside until the next chapter.

(5) The act of piracy is unrealistically, even absurdly, tame. A pirate approaches a fisherman and says politely but convincingly, "Your fish or your life." The fisherman considers the proposal, decides he would rather lose his fish and hands over his catch to the pirate. No fish are destroyed in the struggle over possession. No part of the potential catch is lost from the diversion of the fisherman's time and effort from fishing to the defence of his catch. No part of the potential catch is lost from the fisherman's switch from locations that are relatively more productive but more exposed to predation by pirates to locations that are relatively less productive but less exposed to predation by pirates. The only source of waste in this model of piracy is the loss of the fish that pirates would have caught if they had chosen to become fishermen instead.

The justification for this abstraction from the rough and tumble of conflict is that, though a more realistic model of conflict could be constructed, the simple model focusses more clearly on the main lesson in the example: that the national income may be may be lowered considerably and people may become very much worse off than they might otherwise be when resources are diverted from making things to taking things that others have made. The waste of resources occurs, notwithstanding the balance in the labour market when each person is as well off as he can be - as pirate or fisherman, as predator or prey - in response to the behaviour of the rest of the actors in the economy.

(6) Piracy is wasteful but not injurious or lethal. The taking of fish by pirates involves no fighting, no injury and no loss of life. This is really an aspect of assumption (5) above, but worth singling out to emphasize how much of the reality of conflict is being assumed away. From tribal skirmishes to thermonuclear war, the struggle over goods is fraught with the threat of violence which deteriorates into actual violence from time to time. The threat of violence lies at the core of the fishermen and pirates model, but actual violence is always avoided. This absence of violence is characteristic of economics in general. Fighting, injury, and death will also be abstracted away from the competitive economy in the next chapter. Instead, the world's work is undertaken peacefully as property rights convert universal selfishness into a vast web of cooperation to produce what people want to consume.

(7) There is no rivalry or conflict of interest among fishermen. With enough fishing locations to go round and with all locations equally productive, there is nothing for fishermen to be rivalrous about. No fisherman gets in another's way or affects the size of another's catch. That is why a clear distinction can be drawn between fishermen as producers and pirates as predators.

Normally, the distinction is less clear-cut. At a minimum, some fishing locations would be more promising than others. Especially promising locations would have to be allocated by some competitive process or by rules specifying where each person is entitled to fish. In short, society requires a system of property rights which must be enforced against fishermen as well as against pirates. Switching from fishing to farming, the available land must somehow be allocated among farmers. Sometimes the allocation is accepted without fuss. Sometimes the allocation is the occasion for deadly rivalry.

In practice, the distinction between fishing and piracy is nothing like as precise as it appears in this chapter. People compete as voters over the privileges that government supplies. As will be explained in chapter 5, ordinary production generates "externalities" that are harmful to other people and that governments might usefully constrain. An inevitable vagueness at the edges of property rights generates rivalry among people seeking favorable interpretation. Everybody is both fisherman and pirate in varying degrees. An essential ingredient of a good society is that most of the effort of most of the people is directed toward fishing rather than piracy and that what piracy remains is wasteful but not lethal.

(8) There is no organization. There are no gangs of pirates, no associations of fishermen to defend against piracy, no pirate-fighters among the fishermen and no police. Each person acts entirely alone. This assumption is to be abandoned immediately below with the introduction of an organized police force. Organized police may be quite effective against unorganized pirates, but not completely so. As we shall see, the establishment of the police force imposes a second cost of piracy. The original cost is the reduction in the total catch of fish when some people become pirates rather than fishermen. The extra cost is the additional loss of fish when would-be fishermen become policemen instead. The introduction of the police force is beneficial to the remaining fishermen if the number of would-be pirates deterred exceeds the number of police and as long as the policemen's income per head is kept in line with the income per head of the fishermen. For example, if 7 out of a total population of 10 would become pirates in the absence of a police force and if 2 policemen are sufficient to deter 3 of the 7 people who would otherwise become pirates, then the total catch must increase from 3 to 4 tons and average income increases accordingly.

Before leaving the simple world of pirates and fishermen, I should say again what the story is really about. It is obviously not about the men who fly the Jolly Roger or Sail the Ocean Blue. It is a parable, the simplest parable I could devise, about the two fundamental types of economic activity, about making and taking, about production and predation, and about the waste of resources when effort that might otherwise be devoted to the one is devoted to the other instead.

The story is about the cost of crime as the loss of potential output when some people devote their labour power to stealing or cheating, and as potential victims divert some of their labour from the production of goods and services to defence against theft. Defence against theft may be self-protection (bars on windows, burglar alarms, the hiring of guards, and so on) or the appointment of specialists in crime-thwarting (police, judges, prison guards, and so on). Less obviously, the story is about many socially undesirable but not necessarily illegal activities, as, for instance, when I pollute the air by driving my car or heating my house. In such activities, one and the same person may divide his day between fishing and piracy, between production and predation, where predation in this context is any activity that is harmful to others. That we are all to some extent pirates and that activities with a by-product of piracy may be in the common interest does not exempt me from the charge of participating in anti-social behaviour when my activity is in excess of what everyone in society would agree upon if such agreements could be enforced. The story is also about lobbying, where the activity of the lobbyist is to persuade legislators to favour one industry at the expense of another or to persuade public officials to supply a valuable license to oneself rather than to one's competitor. It is also about certain kinds of speculation where the resources of the speculator are devoted to predicting prices, buying cheap now and selling dear later on, where production is unaffected by the speculator's activity and where the speculator's profit is at the expense of others who would not have sold or would have demanded a better price if the speculator's knowledge had been widely available. More remotely, the model is about monopoly where production is curtailed to raise price.

The story of the fishermen and the pirates may also be looked upon as a parable of warfare among tribes or nations. Tribes fight one another even though they would all be better off if they knew in advance what the outcome of warfare would be, could arrange for a peaceful transfer from one tribe to another of whatever would otherwise be won in battle and could divert the time and effort in fighting to the production of useful goods and services. It is in this context, however, that we see the full force of assumptions 5 and 6, which abstract from the loss of life and the destruction of product that real warfare always entails. The only cost of conflict in the fishermen and pirates example is the waste of labour power that could be used for production instead. That is sufficient for the purpose at hand, which is to demonstrate the potential wastage in predatory behaviour, but one should bear in mind what a small part of the real cost of conflict is actually accounted for.

Above all, the story of the fishermen and the pirates is a counterpoint to the tales economists usually tell - and that I shall tell presently - about efficiency in a free market where the outcome is best for everybody when each person does what is best for himself. In this context, the story of the fishermen and the pirates has a double purpose: to draw attention to the many ways in which unrestricted self-interest may not serve the common good - so that the usual economists' tale turns out to be false - and, more importantly, to emphasize how extraordinary it is that there are any circumstances where the economists' tale does turn out to be true, where the combined effect of a multitude of independent agents each doing what is best for himself without a thought for the welfare of others can be anything but chaotic. The story of the fishermen and the pirates is the preface to the principal story in any work of economics. It is the preface to the story about how private greed is conscripted to the public good when property is secure and when actors in the economy recognize a market-determined set of prices for all goods and services. Familiarity with that story breeds not contempt, but a loss of a sense of wonder that the story is true in any circumstances, however restricted those circumstances may be.

Fishermen, Pirates and Police

A key assumption in the fishermen and pirates model is the absence of organization. Each person acts alone, choosing to be a fisherman or a pirate to maximize his income in response to the choices of every other person in society. Of all the assumptions in the fishermen and pirates model, this is perhaps the hardest to swallow. Fortunately, it is easily replaced, though the society that emerges when it is replaced is not necessarily more attractive. The obvious replacement is to suppose that piracy can be contained, though perhaps not eliminated altogether, by a police force. To characterize the police as simply as possible, we delete assumption (f) in the fishermen and pirates model as set out above, and replace it with assumption (g) about the technology of policing combined with either assumption (h) or assumption (j), to be discussed presently, about the behavior of the police.

(g) The police force consists of c (mnemonic for cops) people, no more and no less. No additional police would improve the effectiveness of the force, but a smaller force would have no impact on piracy at all. Ideally, the police would deter piracy completely. To do so, they would not need to detect all piracy. It would be sufficient for the police to discover a fraction of the pirates, as long as the punishment is severe enough to keep the profession of piracy less attractive than the profession of fishing. That is not what is supposed here. Instead, it is supposed that the police succeed in discovering a fraction, ", of the pirates, but never in convicting them of the crime of piracy because pirates throw their loot overboard when the see the police coming. Assume for simplicity that pirates are never actually punished, but that a fraction of the loot is destroyed by the pirates themselves to avoid detection. The police force is financed by taxation at a rate t of the residual income of fishermen after a part of the catch has been appropriated by pirates. In practice, a society would be able to choose the number of police where, the larger the police force, the greater the deterrence to crime. That flexibility is assumed away here in the interest of clarity and simplicity. Unnecessary complications are avoided by supposing that c is fixed.

Consider a society with N people and L fishing locations, where c people become policemen, the rest choose between fishing and piracy, and the police force destroys a fraction " of the pirates' loot. For such a society, the incomes in the three occupations - fishing, piracy and policing - depend upon the number of pirates, m, and the tax rate, t, imposed by the police on the fishermen.

$$y_f(m, t) = (1- t)(1 - 1/L)^{mS} \qquad (10)$$

$$y_p(m) = (1 - ")[1 - (1 - 1/L)^{mS}][(N-m-c)/m] \qquad (11)$$

and

$$y_c(m, t) = t(1 - 1/L)^{mS}[(N - m - c)/c] \qquad (12)$$

Equation (10) is a modification of equation (3) with the income of the fishermen reduced by taxation to finance the police force. Equation (11) is a modification of equation (4) with the income of the pirates adjusted to account for the reduction in the number of fishermen from (N - m) to (N - m - c) and for the destruction by pirates of a fraction, ", of the loot to evade detection by the police. The income of the pirates does not depend on the tax rate, but the tax rate affects the income of the pirates indirectly by influencing the civilians' (people other than the police) choice between fishing and piracy.

The income per policeman, $y_c(m, t)$ in equation (12), is total tax revenue per policeman. Total revenue is the product of the tax base and the revenue per unit of the tax base. The tax base is the number of fishermen, N - m - c. The revenue per unit of the tax base is the product of the tax rate, t, on fishermen and the pre-tax income per fisherman, $(1 - 1/L)^{mS}$, retained after being preyed upon by pirates.

When total population and the number of locations are large, or when m can be thought of as a continuous variable, people's opportunity to choose between fishing and piracy guarantees that the incomes of fisherman and pirates are the same. By analogy with equation (5) above,

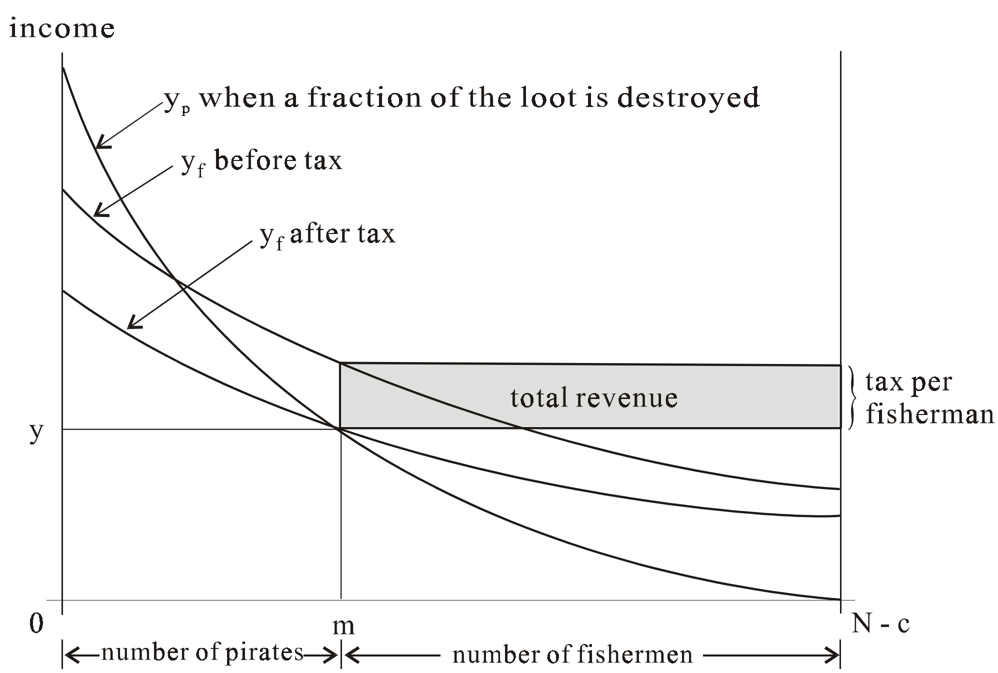
$$y_p(m) = y_f(m, t) \qquad (13)$$

Otherwise, the incomes of fishermen and pirates are connected as described in equation (7).

The total revenue of the police force is illustrated in figure 2 which is a development of figure 1 above. As in figure 1, the number of pirates is shown on the horizontal axis and income, in tons of fish, is shown on the vertical axis. Now, however, there are two vertical axes. The left hand axis is carried over unchanged from figure 1. The right hand axis is placed a distance N - c from the left hand axis, where N - c is the civilian population of fishermen and pirates. For any m, the distance from m to the left hand axis is the number of pirates and the distance to the right hand axis is the number of fishermen, N - c - m. Three curves are shown, two for fishermen and one for pirates. The income-of-the-pirates curve labelled "y_p when a fraction " of the loot is destroyed" shows the value for each m of $y_p(m)$ in equation (11). The higher income-of-the-fishermen curve labelled "y_f before tax" shows the value of $y_f(m, t)$ as it would be if t were set equal to 0. The lower income-of-the-fishermen curve labelled "y_f after tax" shows the value of $y_f(m, t)$ as it becomes when taxation at a rate t is imposed. Equation (13) implies that, for any tax rate t, the number of pirates is determined to equate the income of the pirates and the after-tax income of the fishermen. Their common value - identified by the crossing of the income of the pirates curve and the after tax income of the fishermen curve - is indicated on the figure by y. It is immediately evident from figure 2 that, if the tax rate, t, could be altered while the size of the police force, c, remained the same, then a decrease in the tax rate - by raising the entire after-tax-income-of- the-fishermen curve - must lead to a decrease in the number of pirates, m, and an increase in the common income, y, of the fishermen and the pirates. The opposite is also true. An increase in the tax rate on fishermen decreases the common income of fishermen and pirates.

The total revenue of the police is represented by the shaded area in figure 2. It is product of the tax per fisherman and the number of fishermen, where the tax per fishermen - equal to $t(1 - 1/L)^{mS}$ - is the gap between the fishermen's pre-tax and post-tax incomes. The policemen's income per head is total tax revenue divided by the number of police. At a tax rate of 0, total revenue would be 0. As the tax rate increases, so too does total revenue, but not indefinitely. Eventually, the gain in total revenue from the increase in the tax per fisherman is outweighed by the decrease in total revenue from the tax-induced increase in the number of pirates. There must, therefore, be some tax rate greater than 0 but less than 100% at which total revenue would be maximized.

Figure 2: The Revenue of the Police



How might the tax rate be chosen? Two possibilities will be considered: that the police are responsible to the fishermen, and that the police are predatory. A responsible police force chooses a tax rate, t, to maximize the after-tax income of the fishermen on the understanding that the income per policeman is kept equal to the income per fisherman. A predatory police force chooses the tax rate to maximize tax revenue regardless of the after-tax income of the fishermen. These opposite assumptions about the behaviour of the police will be examined in turn, the first as assumption (h) immediately below and the second as assumption (j) to follow.

A Responsible Police Force

Think of the police force as established in a social "contract" among the entire population, including people destined to become pirates and police as well as people destined to become fishermen. The arrangement is that police are to tax fishermen and hunt pirates as described above, but are to levy taxes no higher than necessary to keep their incomes equal to those of fishermen and pirates.

Assumption h: The tax rate, t, is chosen to equalize the after-tax incomes of the fishermen and the police. Specifically,

$$y_c(m, t) = y_f(m, t) \qquad (14)$$

Combining equation (14) with equations (10) and (12), we see immediately what the tax rate must be. The tax rate, t**, required to equalize incomes of fishermen and police must be

$$t^{**} = c/[N - m] \qquad (15)$$

The police's share of the income of fishermen, after their encounter with pirates but before tax, must equal the police's share of the non-piratical population. Replacing y_f and y_c in equation (13) by their values in equations (10) and (12) and using equation (15) to eliminate t, we see that

$$(1 - ")[1 - (1 - 1/L)^{mS}][(N-m-c)/m] = (1 - 1/L)^{mS} [N - m - c]/[N - m] \qquad (16)$$

which establishes m as a function of the parameters L, ", S and c. The new equilibrium number of pirates will be designated as m** which must be less than m*, the number of pirates as it would be if there were no police force.

The police are beneficial to fishermen and pirates alike if, and to the extent that, the equilibrium number of pirates, m, as computed in equation (16) is sufficiently less than the number of pirates in the absence of a police force to raise all incomes per head. This proposition is illustrated in table 3 and then in figure 3.

Table 3 is a reworking of the data in table 1 with the additional assumptions that 1 of the 10 people is a policeman and that the impact of policing on the economy is to destroy a third of the loot, that is, c = 1 and " = 1/3, so that the income, y_p, of pirates is two-thirds of what it would otherwise be. For any given number of pirates, the expected income per head of fishermen is reduced from what it was in table 1 because the remainder of the catch after the fishermen's encounter with pirates must now be shared with the one policeman. The expected income per head of pirates is twice reduced, once because fewer locations are occupied by fishermen with a catch to steal, and again because the police destroy part of the loot.

Table 3: How the Police Make Everybody Better Off by Harming Pirates

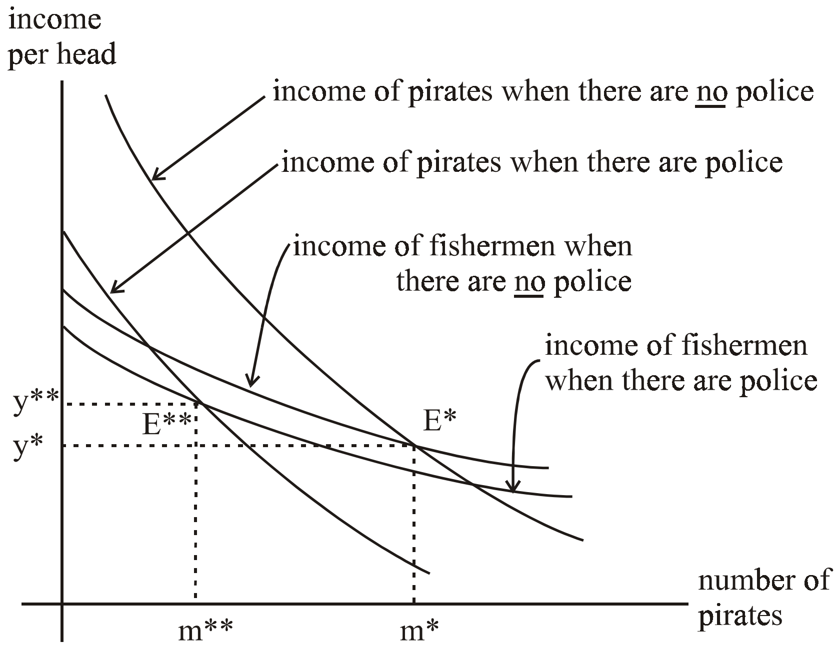
[There are 10 people and 20 fishing locations. Each pirate can investigate 4 locations. One policemen is sufficient to destroy 1/3 of the Pirates' Loot.]

Number of Pirates (m)	Income of Fishermen (y_f, tons per head)	Income of Pirates (y_p, tons per head)	Average Income per Head $\{N- c - m(1 + y_p /2)\}/N$
0	0.9	-	0.9
1	0.7240	0.9893	0.7505
2	0.5805	0.7854	0.6215
3**	0.4631	0.6129	0.5081
4	0.3668	0.4590	0.4034
5	0.2868	0.3421	0.3145
6	0.2190	0.2360	0.2292
7	0.1585	0.1452	0.1492
8	0.0969	0.0672	0.0731
9	-	0	0

Note: a) The incomes of fishermen and pirates are computed for each value of m in accordance with equations (10) and (11). b) From equation (7), it follows that each person is content with his occupation when there are 3 pirates and 7 remaining fishermen; m* = 3 because $y_p(3) > y_f(2)$ but $y_p(4) < y_f(5)$. c) Comparing table 3 with table 1, we see that the establishment of the police force increases each fishermen's income from .2378 tons per head to .4631 tons per head, and increases each pirate's income from .3267 tons per head to .6129 tons per head. Everybody has been made better off.

Police aid fishermen by reducing the equilibrium number of pirates at which everybody is content to remain in his present occupation. With no police force, there would be seven pirates, the income of fishermen would be 0.2378 tons per head and the income of pirates would be 0.3267 tons, as shown in table 1. With one policeman who destroys a third of the loot, the number of pirates is reduced from seven to three, the income of fishermen rises to 0.4631 tons and the income of pirates rises to 0.6292 tons. By making fishermen somewhat worse off and pirates very much worse off for any given number of pirates, the police force makes everybody better off when people are free to choose between fishing and piracy.

Figure 3: How a Responsible Police Force Raises the Incomes of Fishermen and Pirates



The contrast between an economy without police and an economy with police is illustrated in figure 3, an extension of figures 1 and 2. As in figure 1, the vertical axis of figure 3 shows incomes of fishermen and pirates, and the horizontal axis shows the number of pirates looked upon as a continuous variable rather than an integer. With no police force, the income-of-the-fishermen curve and the income-of-the-pirates curve intersect at E*, signifying that there are m* pirates and that the common income of fishermen and pirates is y*. The introduction of the police lowers both curves. The income-of-the-pirates curve is lowered because part of the loot is destroyed. The income-of-the-fishermen curve is lowered because fishermen are taxed to finance the police force. The new intersection is at E**, signifying that there are m** pirates and that the common income of fishermen and pirates is y**. A responsible police force lowers the income-of-the-pirates curve by significantly more than the income-of-the-fishermen curve so that the number of pirates at which people are indifferent between fishing and piracy is reduced substantially and the common income of fishermen and pirates is increased. In short, a benevolent police force works as it should when m** is sufficiently less than m* that y** is greater than y*, even though both curves are depressed.

The income-of-the-pirates curve and the income-of-the-fishermen curve in figure 3 are both lowered by the activity of the police, but the income-of-the-pirates curve is lowered by sufficiently more than the income-of-the-fishermen curve that everybody's net income per head is increased when each person is content with his new choice of occupation, given what everyone else is doing. This must be so, for otherwise no responsible police force would ever be established. An odd implication of this line of reasoning is that everybody, even pirates, favours severe punishment for piracy because, the larger the fraction of the pirates' loot destroyed, the smaller the number of pirates in equilibrium and the larger everybody's income will be.

A Predatory Police Force

The life of the fisherman becomes less attractive with the abandonment of assumption (h) that the income of the police is kept equal to the income of the fishermen they serve. The assumption may seem reasonable for contemporary societies where the incomes of actual policemen are not incommensurate with the incomes of similarly skilled people in the private sector. The assumption is less self-evident when the police in our example are seen as representative of government as a whole. Throughout most of recorded history, a ruling class has ruled in its own interest primarily and has provided its members with far larger incomes than their subjects could ever hope to earn.

The story of the police has been told so far as though the police force were established in a social contract where all people combined to establish rules in their common interest, and as though, once established, the contract were respected by everybody forever. Such a contract might well have stipulated that the incomes of the policemen will not exceed the incomes of fishermen. There are, however, other less attractive and historically more realistic possibilities.

The king, ruling class or police force (whatever one wants to call it) may have emerged not by social contract, but out of conflict among pirates for control of the loot. Recall the stipulation in assumption (d) that pirates prey on fishermen but never upon one another. Why not? Would it not be more reasonable to suppose that pirates form groups which fight among themselves to acquire a monopoly of the loot, and that one group of pirates emerges victorious? Kings have sometimes been appointed by subjects, but normally kings seize power and tell nice tales afterwards to legitimize their regimes. William the Conqueror's acquisition of England is perhaps the typical case. Every dynasty in the history of China - and the present regime is no exception - began as a gang of bandits that succeeded in establishing order at a time of chaos. Eventually, successfully organized bandits acquire legitimacy but not benevolence. Society would still be ruled in the interest of rulers rather than subjects. Concern for the welfare of subjects would extend no farther than is conducive of the rulers' "own strength and glory." Within our model, society would be conducted to maximize y_c regardless of the consequences for y_f and y_p.

Even if established by social contract, a police force may turn predatory because its powers over the citizen cannot be contained. To combat piracy, the police force - representative here of the entire paraphernalia of law enforcement and government - must be organized as a hierarchy with a monopoly, or near monopoly, on the means of violence. A country can have only one army. A second army would fight with the first, destroying the order and security in society that an army is designed to protect. There can only be one head of state, one ministry of finance, one central bank, one federal bureau of investigation. This is something of an exaggeration. A country may have a federal, as opposed to unitary, government. State governments may share power with the central government. The powers of the central bank may be divided among several reserve banks in different parts of the country. There may be a sharing of powers between the Federal Bureau of Investigation and the Central Intelligence Agency. Much of this diversity is a parcelling out of the different functions of government among separate branches, organizations or ministries, but there may be some genuine competition or deliberate duplication of functions. A founding principle of the government of the United States was the division of powers among executive, legislature, and judiciary, and the further division of the legislative power into the Senate and the House of Representatives providing checks and balances as a defence against arbitrary power. Yet there remains a residue of unity of organization in government, a unity not found in the private sector of the economy where each fisherman and each pirate acts in his own interest exclusively. Regardless of how government came to be, it is precisely this unity of organization which is at once reason why a small number of police may prevail over a potentially large number of pirates and why a government may come to exploit the fishermen it protects.

Passage from responsible to predatory government can be modeled as the replacement of assumption (h) with assumption (j), or, equivalently, as the replacement of equation (14) above - specifying equality of income between the fishermen and the police - with the establishment of a higher rate of tax, t***, that maximizes the income of the police, y_c.

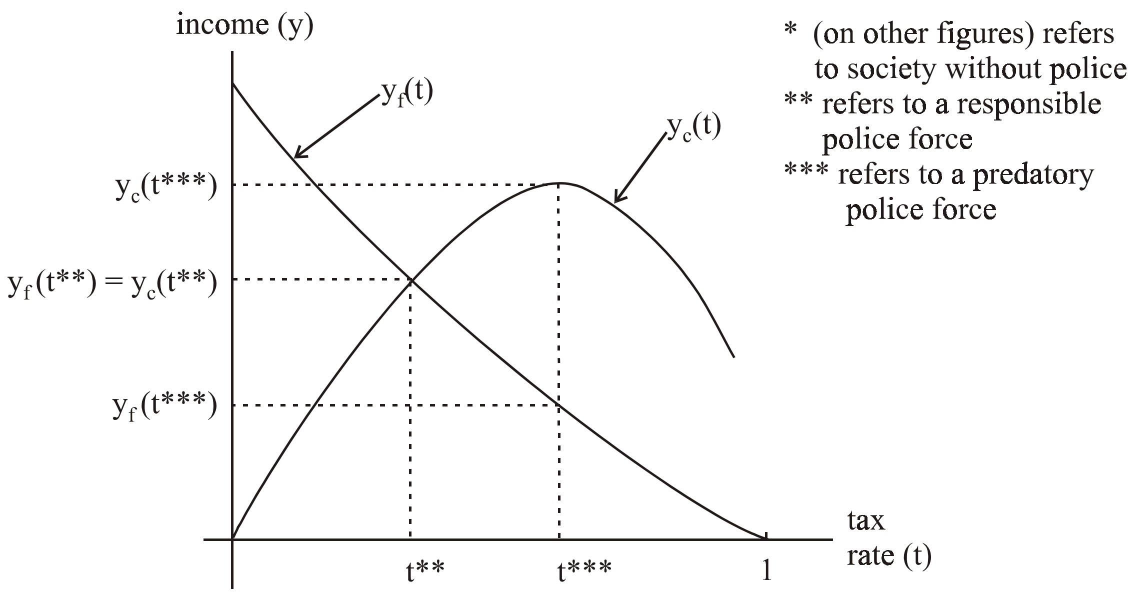
Assumption (j): Police tax fishermen at a rate t, chosen not to equalize incomes of fishermen and police as in assumption (h), but to maximize the income per head, y_c, of the police. Pirates cannot be taxed.

On this assumption, our description of the environment of the fishermen, pirates and police boils down to a system of five unknowns constrained by four equations. The five unknowns are y_f, y_p, y_c, m and t. The four equations are (10), (11), (12) and (13), specifying the incomes of fishermen, pirates and police and then constraining the incomes of fishermen and pirates to be the same. In such a system the four equations can be employed to represent any four of the unknowns in terms of the fifth. As we are focussing on the police force's choice of the tax rate, it is useful to express the first four the unknowns as functions of t. Thus, the incomes of the fishermen and the police - originally expressed in equations (10) and (12) as functions $y_f(m, t)$ and $y_c(m, t)$ of m and t - can be reconstructed as functions $y_f(t)$ and $y_c(t)$ of t alone.

These functions are plotted on figure 4 with income in the vertical axis and the tax rate on the horizontal axis. As already illustrated in figure 2, the income of fishermen, $y_f(t)$, declines steadily as the tax rate increases. The very best outcome for the fishermen would be for the police to provide its deterrence to piracy free of charge. The income of fishermen is as high as possible when t = 0 and it declines steadily with every increase in t. The direct effect of an increase in the tax rate on the residual income of the fisherman-taxpayer is reinforced by the indirect effect of the tax-induced increases in the number of pirates and the corresponding increase in the share of the fisherman's catch lost to piracy.

By contrast, the relation between the tax rate, t, and the income of the police, $y_c(t)$, is humped. The police acquire no income at t = 0, and their income increases with t up to a maximum beyond which any additional increase in the tax rate reduces everybody's net income: fishermen, pirates and even the police. The choice of the tax rate is a balancing of three considerations. The higher the tax rate, the larger is the portion acquired by the police of what is left of each fisherman's catch after the fisherman's encounter with pirates, the lower is the number of fishermen subject to tax and the larger is the pirates' share of the total catch. Recall that a responsible police force would set the tax rate at t** where $y_c = y_f$. Freed from that constraint, a predatory police force chooses t*** to maximize $y_c(t)$ regardless of the impact on the income of the fishermen. The tax rate t*** must be larger than t** but still less than 100%. (We are adopting a convention where * refers to outcomes in the absence of a police force, ** refers to outcomes when the police force is responsible and *** refers to outcomes when the police force is predatory. Necessarily, t*** > t** > t* = 0.) It is true, almost by definition, and immediately evident from figure 4 that fishermen are worse off when the police are predatory than when the police are responsible.

Figure 4: How Incomes of Fishermen and Police are Affected by the Tax Rate



Is a Predatory Police Force Better than None?

The quotation at the beginning of this chapter leaves no doubt about Thomas Hobbes's view on the matter. Writing in the midst of the English Civil War, he saw firm government, however predatory, as preferable to the chaos around him. Our model suggests the opposite, though Hobbes' view acquires weight from a reconsideration of our assumptions.

As shown in the discussion surrounding table 1, the option of piracy is an unmitigated harm to fishermen in the absence of a police force. Strangely enough, the option of piracy may be converted from a harm to an advantage when the police force is predatory. Two predators may be better for the prey than just one. The private predator may neutralize the public predator to some extent. The public predator exploits his prey through taxation. The private predator constrains the public predator by allowing the tax base to shrink as the rate is increased, supplying the public predator with a motive for taxing at a rate well short of 100% and leaving the prey with some net, after-tax income.

The worst possible situation for the fishermen (within the context of our model) is where a predatory police force can deter piracy altogether. Without piracy or the possibility of piracy, equations (11) and (13) become irrelevant and equations (10) and (12) reduce to

$$y_f(t) = (1 - t) \qquad (17)$$

and
$$y_c(t) = t[(N - c)/c] \qquad (18)$$

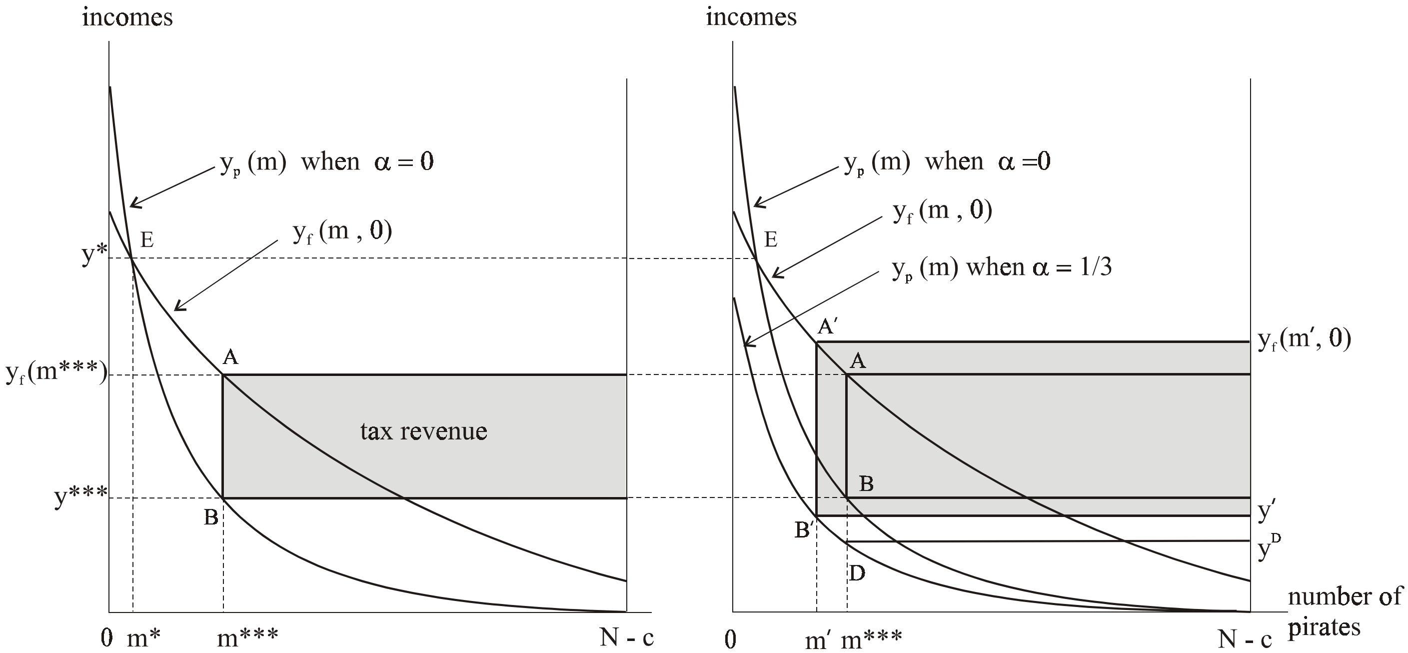
From these equations, it is immediately evident that the income of the police is as large as possible when the tax rate, t, is set equal to 1. The police acquire an income per head of (N-c)/c with nothing left over for the fishermen at all. Without piracy as a constraint, nothing within the model we have constructed stops a predatory police force from appropriating the entire catch by imposing a tax rate of 100%. Since fishermen retain some fish in the absence of the police force and no fish in the presence of a predatory police force, the former must necessarily be preferable. For the fishermen, under our assumptions, predatory government without the possibility of piracy is the worst of all possible worlds. Thus far, Hobbes turns out to be wrong.

However, our main question is not whether the prospect of piracy increases the income of fishermen when the police force is predatory, but whether a predatory police force increases the income of fishermen in an environment where fishermen may turn to piracy. This is the question to which Hobbes gives an unambiguously affirmative answer. Interestingly enough, Hobbes turns out to be wrong once again within the strict confines of the model we have constructed. To facilitate the exposition within the confines of the model, the matter is examined in two stages. In the first stage, the police force is assumed to be predatory but ineffectual in deterring piracy. The tax rate is set to maximize total revenue, but the value of " is set equal to 0, indicating that the police destroy none of the pirates' loot. It is hardly surprising that such a police force is no help to the fishermen. In the second stage, the value of " is set greater than 0, indicating that police do destroy a portion of the pirates' loot. This is the case for which we might suppose that even a predatory police force would be helpful, but that turns out not to be so.

The argument is developed with reference to figure 5 containing two variants of figure 2 side by side. The left hand side shows interactions between fishermen and pirates when the police are ineffectual. The right hand side reproduces the left hand side together with an additional curve illustrating the response of a predatory police force to an increase in its capacity to deter piracy.

The left hand side shows the income-of-the-fishermen curve *as it would be* if fishermen were untaxed and the income-of-the-pirates curve *as it would be* if pirates kept all their loot. These curves can equally well be thought of describing a society with no police at all but with a population of N !c rather than N. The equilibrium number of pirates would be m* and the common income of fishermen and pirates would be y*, identified by the crossing at the point E of the income-of-the-fishermen curve and income-of-the-pirates curve. When fishermen are taxed at a rate t but pirates are left alone, a gap emerges between the before-tax income of fishermen, $y_f(m, 0)$, and the after-tax income of fishermen, $y_f(m, t)$, for every value of m. The gap is illustrated as the distance from A to B, and the new equilibrium number of pirates is that for which $y_f(m, t)$ equals $y_p(m)$ as it would be when " = 0. The number of pirates increases from m* to m***, and the common income of fishermen (after tax) and pirates falls from y* to y***. It is immediately evident from the figure that, by levying the revenue-maximizing rate of tax, a predatory but ineffectual police force makes fishermen and pirates worse off than they would be with no police force at all.

Figure 5: How Predatory Government May Be Worse For Fishermen than No Government



a) Piracy Undetected by Police (α = 0) b) Piracy Detected by Police (α = 1/3)

Matters become even worse when the police deter piracy. One might expect a police force that deters piracy to be preferable to a police force that fails to do so, and, as shown in the discussion surrounding figure 3, this turns out to be so when the police force is responsible. It is not so when the police are predatory. On the contrary, the more effective the police in deterring piracy, the worse off do fishermen and pirates become. The reason is that, with piracy deterred, the only constraint on the police is eliminated, and the police can levy as high a tax as they please with no significant shrinkage of the tax base.

The right hand side of the figure reproduces the left hand side together with one extra curve, the income-of-the-pirates curve as it becomes when the police deter pirates to some extent. Specifically, this modified income-of-the-pirates curve is placed one-third below the original income-of-the-pirates curve on the assumption that " = 1/3. As the figure is drawn, the new, lower income-of-the-pirates curve lies entirely below the income-of-the-fishermen curve, so that piracy would be eliminated altogether, and the fishermen's income would be as large as possible, if the police force were responsible and if the gap between the income-of-the-fishermen curve and the income-of-the-pirates curve were large enough at m = 0 for the police force to be adequately financed when $y_c = y_f$.

A predatory police force responds differently. The lowering the income-of-the-pirates curve supplies the police with an opportunity to raise the tax on fishermen without decreasing the tax base. A predatory police force exploits that opportunity to expand its revenue as much as possible. The police could raise the tax per fisherman from the distance between A and B to the distance between A and D, leaving the number of pirates unchanged and lowering the common income of fishermen and pirates from y*** to y^D. But that is not the police's best option. Instead, the police can raise their incomes still further by lowering the tax rate slightly, reducing the number of pirates from m*** to m▯, increasing its tax base from N ! c ! m*** to N ! c ! m▯ and increasing the common income of fishermen and pirates from y^D to y ▯. Typically, as shown in the figure, y ▯ would be still less than y***, the fishermen's income as it would be if " were equal to 0. The greater the deterrence to piracy, the smaller the after-tax income of fishermen becomes.

The new, larger tax revenue of the predatory police force is the shaded area on the right hand side of the figure. We know already that, in the limit where " increases to 1, there is nothing to stop a predatory police force from appropriating the entire catch by setting t = 1. As the curves are drawn, the increased effectiveness of the police against pirates raises tax revenue but leaves civilians worse off than before. Once again, Hobbes appears to be wrong. The option of piracy is advantageous to fishermen when the police are predatory. A predatory police force is harmful to fishermen with or without the option of piracy.

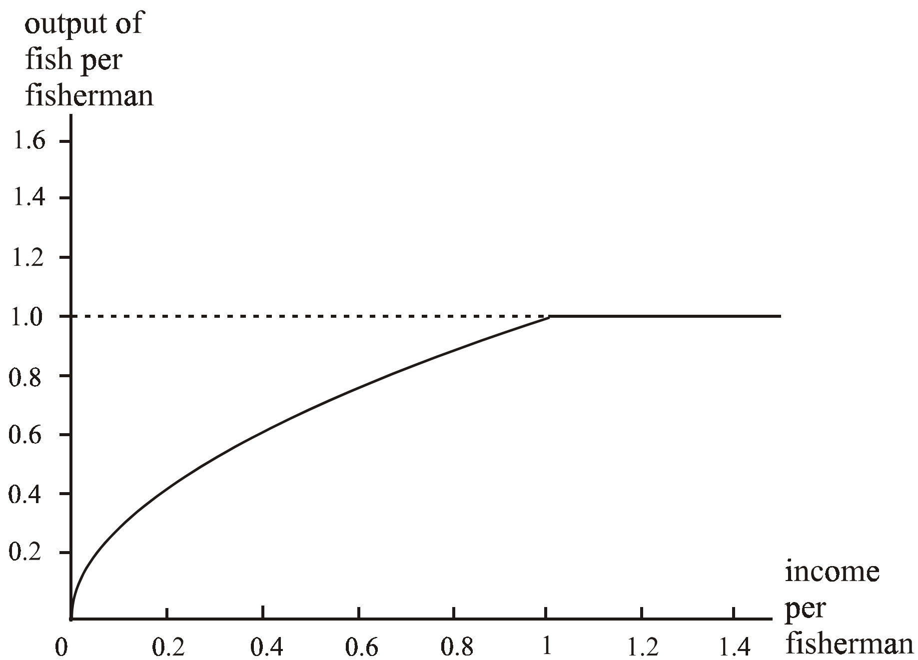
Another consideration may reverse this conclusion. A so far underemphasized assumption of the fishermen and pirates model (assumption c) is that each fisherman catches one ton of fish per day regardless of anything else in the model. That the catch is one ton rather than some other amount is of no importance. That the catch remains invariant is crucial because a predatory police force would acquire an incentive to moderate taxation of fishermen if a lowering of the fisherman's income reduced his capacity to work or if taxation impeded productivity in some other way. One's capacity to work may increase gradually together with one's after-tax income. A wise ruler would take that into account.

Replace the assumption that each fisherman catches 1 ton of fish with the assumption that a fisherman catches f tons, where f is a concave function of the fisherman's net (after tax) income; as the fisherman's net income increases, his productivity increases too, but at a decreasing rate. Specifically, the output per fisherman is reduced from 1 ton per day (as in assumption (b) to f tons per day where

$$f = \text{the smaller of } \{ / y_f , 1\} \qquad (19)$$

and where y_f is the fisherman's after-tax income. The relation in equation (19) between the fisherman's net income and his productivity is illustrated in figure 6 with net income, y_f, on the horizontal axis and productivity, f, on the vertical axis. This equation specifies that a fisherman can never produce more than one ton of fish, but he produces less whenever his after-tax income falls below one ton.

Figure 6: How the Output of a Fisherman Increases with His Income



Equation (19) reduces immediately to

$$f = / y_f \qquad (20)$$

whenever $y_f < 1$ as it must be when fisherman are taxed. Thus, when fishermen are taxed at a rate t and when the option of piracy is eliminated altogether, the income per head of fishermen in equation (17) is transformed into

$$y_f(t) = (1 - \; t)f \qquad (21)$$

From equations (20) and (21), we see at once that $y_f(t) = (1- t) / y_f(t)$ or

$$y_f(t) = (1 - t)^2 \qquad (22)$$

and

$$f = (1 - t) \qquad (23)$$

Also, once piracy is eliminated, the income of the police in equation (18) becomes

$$y_c(t) = tf[(N - c)/c] = t(1 - t)[(N - c)/c] \qquad (24)$$

Consider a society of 10 people where 2 people acting as policeman are sufficient to deter piracy altogether. A responsible police force sets the tax rate, t, so that $y_c = y_f$. Equating incomes of fishermen and police in equations (22) and (24), we see that $(1- t)^2 = t(1 - t)[(N - c)/c]$, from which it follows that $(1 - t)/t = (N - c)/c = 4$, or t = 20%. Plugging that value back into equations (22), (23), and (24), we see that the productivity, f, of fishermen must be 0.8 tons of fish (rather than 1 ton) and the common income of fishermen and police together must be 0.64 tons of fish per person. By contrast, a predatory police force sets the tax rate to maximize y_c regardless of y_f. It sets a tax rate of 50%, reducing the productivity of the fishermen to 0.5, raising the income of the police from 0.64 to 1, and lowering the income of fishermen from 0.64 to 0.25 tons of fish per person[1]. Clearly, fishermen are better off with a benevolent police force than with a predatory police force.

Has a predatory police force become better for the fishermen than none at all? It was distinctly worse when the productivity of fishermen was assumed to be invariant. Now the opposite may be so, depending on how many pirates there would be with no police force to intercept their loot. With m pirates out of a total population of N, the common income of fishermen and pirates must be (N-m)f/N tons of fish per day. From equation (20), it follows immediately that the common income reduces to $[(N-m)/N]^2$ tons of fish.

With only 1 pirate (that is, if m = 1), the common income of fishermen and pirates must be 0.81. Were that so, fishermen would be better off without any police, responsible or otherwise. No responsible police force would ever be established, and a predatory police force, yielding fishermen an after-tax income of 0.25, would clearly be worse than none. With 3 pirates, the common value of y_p and y_f would be 0.49 which is worse for fishermen than if there were a responsible police force, but better than with a predatory police force. With as many as 7 pirates (the equilibrium number in figure 1), the common value of y_p and y_f would be 0.09 which is worse for fishermen not just with a responsible police force, but with a predatory police force as well. The essence of the example is that the tax imposed by a predatory police force may be constrained by more than the threat of piracy. It may also be constrained by the impact of taxation on the productivity of the labour force, and, if so, even a predatory police force can be preferable for the fishermen to piracy.

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[1]The police choose t to maximize t(1 - t) in equation (24). The best tax rate for the police is ½. To see that this is so, suppose instead that t = ½ +) where) is any number less than ½. The value of t(1 - t) becomes (½ +))(½ -)) = 1/4 -)^2 which is as large as possible when) = 0 signifying that t = ½.

The principal difference between piracy and a predatory police force is that a predatory police force takes account of the effects of its actions on the productivity of the fishermen. Each pirate acts in his own interest exclusively regardless of the effects of his actions not just on fishermen, but on other pirates as well. A pirate who appropriates a fisherman's catch does not consider the productivity of fishermen as a whole. Better take the fruit today even though the tree is placed in jeopardy, for, if I do not take the fruit, then somebody else will. I have every incentive to behave this way though I know full well that all pirates are worse off than they might be when every pirate acts as I do. An organized and unified police force is never confronted with this dilemma. Cognizant of the full consequences of its actions, a predatory police force allows fishermen a high enough income to work well. This entirely self-interested restraint may supply fishermen with larger incomes than they would acquire with no police force at all.

Much depends on the size of the population and the availability of resources. Within the formal model of fishing and piracy in the absence of the police, the relative advantages of the two occupations - reflected in the heights of the income-of-the-fishermen curve and the income-of-the-pirates curve - depend on total population, N, and on the number of fishing locations, L. Consider the determination of the income of the fishermen, y_f, and income of the pirates, y_p, in equations (3) and (4). With N held constant, an increase in L raises y_f and lowers y_p for any given number of pirates, m. Thus, the larger L, the smaller the equilibrium m must be, the larger is the common income of fishermen and pirates, and the less likely it becomes that any police force, responsible or predatory, can be advantageous. The same holds true when L is held constant and N is reduced. Generalizing, it is often claimed that a condition of anarchy, among people or among tribes, may be tolerable in sparsely settled regions, but becomes intolerable, and is terminated by the establishment of government, once population density is increased.

One final consideration should be mentioned briefly. Organization requires hierarchy with its own costs to society, especially to fishermen at the bottom of the economic and social scale. Until very recently, hierarchy could not be maintained without a supreme ruler at the apex and a ruling class between the emperor and the ordinary subject. As already mentioned in chapter 1, emperors were literally deified, a ruling class was raised above the ordinary run of mankind and no common humanity was recognized in the law. Members of the ruling class come to see themselves almost as a different species from their subjects and to treat them accordingly. Invested with great power over the rest of society, rulers might from time to time turn out to be foolish, evil or insane. Enormous harm can be inflicted on the innocent many at the whim of the omnipotent few.

The story of the fishermen and the pirates raises three questions that will occupy us throughout this book.

(1) What in practice, is are fishing and piracy? Every society must draw a line between activities to be restricted because, in Mill's words quoted at the beginning of this chapter, "efforts and talents in the world are employed in merely neutralizing one another" and activities to be permitted or encouraged because they are "the legitimate employment of the human faculties, that of compelling the powers of nature to be more and more subservient to

physical and moral good.” Passing from the economy in this chapter with only one good, fish, to real economies with a virtually infinite variety of goods and industrial processes, it becomes less evident which among the multitude of privately advantageous activities are like fishing and which are like piracy. Many activities are like fishing in some respects and like piracy in others. Societies must decide which activities to permit, which to regulate and which to prohibit altogether. The great lesson of economics, alluded to in the first few paragraphs of this chapter and to be discussed in detail in the next, is that much of what goes on in the private sector of the economy is fishing and that some notion of the common good is fostered when property rights are protected and markets are otherwise left alone. As we proceed, we shall acquire lists of virtues of the market and of types of self-interested behaviour with fringes of piracy calling for intervention by the state.

(2) What is the job of the police? A second line must be drawn between socially advantageous activities that people undertake voluntarily because it is in their interest to do so and socially advantageous activities that have to be undertaken collectively if they are to be undertaken at all. In this chapter, the only role of government is to protect fishermen by hunting pirates. Protection of life and property is always the rock-bottom minimal role of government, but complex societies require more. People act collectively or consign decision-making to a central authority in specifying and administering a vast web of laws, in delineating the scope of property rights (for instance, rules about the formation, rights and obligations of corporations), in the building and maintenance of roads and other public works and in dealings with other countries. Societies decide collectively about the boundary between political and economic rights in the redistribution of income and in public provision of medical care and education. Among the considerations in drawing the line between public and private sectors is that large governments may turn predatory. The larger the public sector, the greater the risk of its acquiring a will of its own quite apart from the interests of the population as a whole.

(3) How can the police be kept responsible? In one variant of our story, the police were responsible. In another, they were predatory. Nothing was said about why the police might turn out one way or the other, or about how to design institutions to constrain private predation without at the same time introducing public predation in its place. “Who guards the guardians?” This fundamental question of political theory will not be settled in an introductory textbook of economics, but it lies in the background of the examination of voting, public administration, and law in chapters 9, 10, and 11. There is a special connection between markets and responsible government. It will be claimed that government cannot be responsible unless elected, that the institution of voting self-destructs unless the domain over which we vote is constrained, and that the market frees government from tasks it cannot perform without at the same time ceasing to be responsible to the electorate.