HOW GENERAL IS THE HUBBERT CURVE? THE CASE OF FISHERIES

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The Hubbert model of crude oil production can describe several regional cases, but it is not yet generally accepted as being of validi for all cases, especially for the worldwide case of oil extraction. The present paper shows that the model is of general validity to describe cases in which a resource is depleted faster than it can be replaced, as in the case of biological resources. In some cases, historical fishery data appear to be relevant for understanding the present price trends of crude oil.

I. INTRODUCTION

In the 1950s, M. K. Hubbert was the first to use a symmetric bell shaped curve to fit the production trends of crude oil. The method turned out to be successful in describing the production of the 48 lower US states and in predicting the peak year (1971). There are several other regions of the world where oil production also followed a single bell shaped curve and others where a number of bell curves can be identified (1).

If the global oil production curve will follow Hubbert's model, that is it will follow bell shaped, symmetric curve, the consequences on the global economy are potentially enormous. However, doubts have been cast on the general validity of the Hubbert model (see, e.g. (2)).

As shown in (3,4) the Hubbert model can be derived from general assumptions. Nevertheless, the confidence placed on the use of a specific model to describe a system ultimately derives from its successful use in describing historical cases. There is no doubt that Hubbert curves describe *regional* cases of the extraction of crude oil and of other mineral resources, but there no precedent, so far, of a mineral resource terminally depleted worldwide.

However, since the Hubbert model is of very general applicability, it should be valid not only for mineral resources but for all cases in which a resource is depleted much faster than it can be replaced. This is the case of some biological resources, e.g. fisheries, where several examples of total, or nearly total, depletion of the resource are known. Cases which are especially interesting for a comparison with worldwide crude oil depletion are those where a) a resource went through a complete depletion cycle b) the market for that resource was global, or at least limited to a closed economic region and c) there was no equivalent resource able to substitute the depleted one. From these cases we can also obtain relevant information about price trends over the whole depletion cycle. We show here that for the cases for which data exist, prices show a tendency to exponential growth after the Hubbert peak.

II. HISTORICAL CASES

A complete Hubbert cycle can be observed for whale hunting in 19th century (data from ref. 5). (fig. 1).

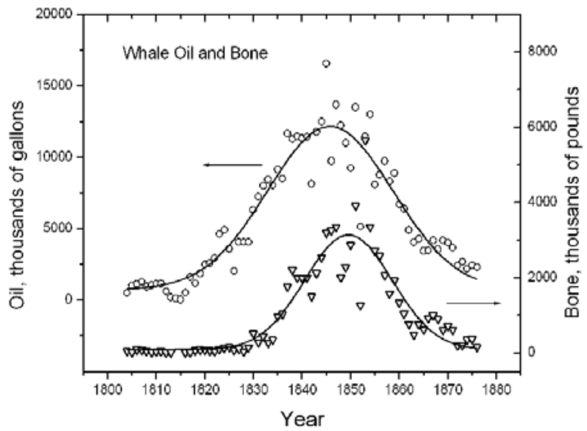

Fig. 1 Production of whale oil and whale bone (baleen)

As reported in more detail in (6), the production curves for both whale oil and "whale bone" (or "baleen") followed a symmetric bell shaped curve The market of whale oil was global already in 19th century and its decline was caused by depletion and not, at least at the beginning, by the shift to a different resource. Here, the data have been fitted with a simple Gaussian curve which was shown to provide a good approximation for the Hubbert model (3)

The price data for whale oil (corrected for inflation (7)) are reported in fig 2 as a function of depletion. The data show a considerable upwards jump at ca. 60% depletion, i.e. some time after the Hubbert peak, followed by a plateau. Plotted as a function of time, the price of whale oil shows an exponential rise after the peak.

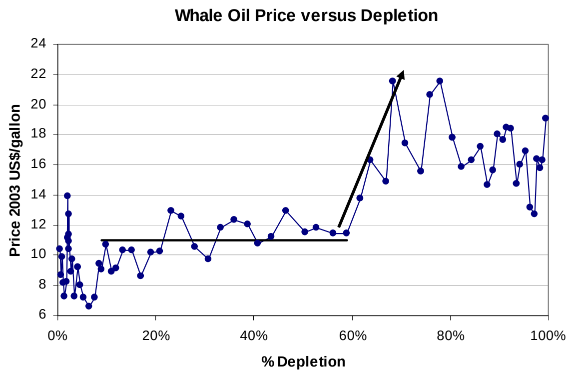

Fig 2: Whale oil price versus depletion

Another case, similar to that of whales, is that of the Caspian sturgeon, the source of caviar. The data for worldwide sturgeon landings (8) are shown in fig. 3.

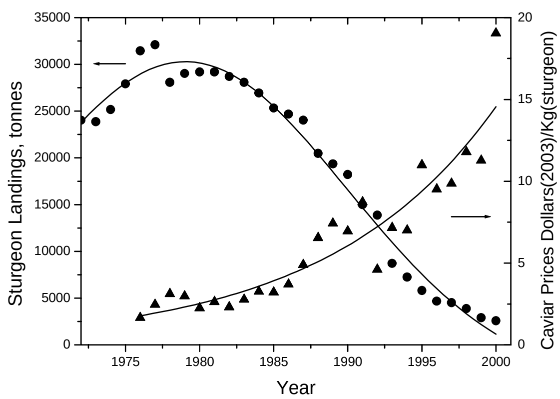

Fig 3. Prices of caviar and sturgeon landings

The production data have been fitted with a Gaussian function. Inflation corrected prices for caviar (7) show a rising exponential growth starting after the Hubbert peak. Here, the price plateau observed for whale oil does not occur. The difference can be explained considering that the plateau for whale oil prices may be due to the development of crude oil as a replacement for whale oil, whereas no such replacement exists for caviar.

Examining fishery data, several other cases of bell shaped production curves can be found. For the case of Tasmanian scallops, three distinct bell shaped production curves can be observed. Also in this case, price data exist and do indicate an exponential growth after the production peak. Even the global fisheries production may be following a bell shaped curve which may have peaked in the early 1990s (9).

III. CONCLUSION

The comparison of fisheries and of mineral extraction shows that the human pressure on the environment is causing a wide range of resources to go through a depletion cycle which follows Hubbert's law. The case of some fisheries; sturgeons 19th century whales, and scallops may be especially relevant for the comparison with conventional crude oil extraction. In all these cases, we have a non-replaceable, or at least not easily replaceable, resource being depleted worldwide. If these are representative examples of price trends for resources which undergo total depletion, we may expect the price of conventional crude oil to start an exponentially rising trend in the vicinity, or slighlty after, the Hubbert peak. The fact that such an exponential rise may have already started is an indication that we may be close to, or have already passed the peak

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