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International Council for the Exploration of the Sea

C.M. 1970
Special Meeting on
"Measurement of Fishing Effort"
No. 13

Relationship between fishing power and vessel characteristics of Belgian beam trawlers

by

P. Hovart x) and K. Michielsen xx)

INTRODUCTION.

The International Council for the Exploration of the Sea passed in 1968 the following resolution : "a Working Group (is) set up ... to study the problems of evaluating the various characteristics of fishing vessels in terms of their effect on fishing effort measurement ...".

In the scope of the activities of the Working Group, Belgium was invited to study the relationship between fishing power and some vessel characteristics of beam trawlers.

Beam trawling is appropriate either for fishing shrimps or flatfishes. It was agreed to work on flatfishes, especially on sole. As in this kind of fishery, fishermen tend to use quite similar gear, it may be expected that bias owing to differences in fishing gear has largely been eliminated.

x) P. Hovart
Fisheries Research Station,
Ostend, Belgium.

xx) K. Michielsen
Fisheries Division
Ostend, Belgium.

MATERIAL AND METHODS.

The statistical material covers the period april-june 1968 and 1969.

In 1968 sufficiently numerous data concerning rectangles 102 and 202 were available, involving the catches of respectively 32 and 33 ships. In 1969 however only data concerning rectangle 102 could be used, covering the catches of 43 ships, the number of trips recorded in rectangle 202 being too small.

The period april-june was chosen as most landings of sole by beam trawlers are recorded in these months (about 55 % in 1968 and 60 % in 1969). Furthermore, in this period, soles are mostly captured by beam trawlers in the rectangles 102 and 202.

The data were obtained from the auctions regarding the catches and from the skippers' logbooks concerning the fishing area, hours fishing etc.

Figure 1 shows the fishing area studied, i.e. a small part of region IVc.

Table 1 gives a general impression on the variation of the vessel characteristics.

The gear consists of twin beam trawls towed over port and starboardside of the vessel and measuring approximately 5-6 m along the beam, while 4 to 6 tickler chains are rigged in front of the ground rope.

Although measurement of parameters such as tonnage, engine output and length is object to discussion (de Boer, de Beer, 1970), we used as independant variables gross tonnage, brake horse power and registered length as they are mentioned in the ship certificate ; more refined data not being available.

The dependent variable is the fishing power, or more precisely the relative fishing power.

This relative fishing power was calculated by the method described by Gulland (1956) : the relative fishing power for a number of standard ships was calculated and the fishing power of other ships was obtained by reference to these former standard ships.

These variables allow to compute a correlation-matrix, partial correlation coefficients and regressions.

The correlation-matrix of fishing power, gross tonnage, engine power and length gives an idea about the relationship between the variables while indicating the value of this relationship.

Partial correlation coefficients estimate the correlation between two variables in a multivariable problem under the restriction that any common association with the remaining variables (or some of them) has been "eliminated".

From data of fishing power, gross tonnage, engine power and length the following equations were derived :

$P = a' + b'X$
(X being gross tonnage, engine power or length).

$P = aX^b$
or $\log P = \log a + b \log X$
(X being gross tonnage, engine power or length).

To calculate the regressions and correlations, data of individual ships have been used, i.e. individual estimates of fishing power, tonnage, engine power and length.

Finally, it must be mentioned that all estimates were tested on significance.

RESULTS.

1. Table 2 (a) as well as table 2 (b) show that the three characteristics are significantly correlated with the fishing power, however engine power being the closest.

It can be presumed that for short trips to rather near fishing grounds as beam trawlers on sole normally make, gross tonnage, and length are of less importance than engine power, which is needed to tow the two nets with a number of heavy tickler chains in front of the ground rope.

The highest correlation coefficient between fishing power and engine power was obtained in 1969 for rectangle 102, with $R = 0,724$ in a non-linear relation and $R = 0,700$ in a linear equation.

An non-linearr function is more appropriate to illustrate the observations ; we suggest that an exponential relationship is of proper use for our investigation.

2. Table 2 shows that the variables gross tonnage, engine power and length are interrelated, so that when calculating a multiple regression, the regression coefficients cannot be estimated with accuracy.

3. So far only one factor at a time has been considered.

From tables 3 (a) and (b), which give the partial correlation coefficients, it can be noticed that lower, but still significant correlations are found between fishing power and engine power when the effect of gross tonnage and/or length is removed.

On the contrary correlations disappear or are non-significant when engine power is eliminated and other combinations of variables are made.

4. Regressions are given in tables 4 (a) and (b).

Although the relationship between fishing power and vessel characteristics may be complex, the results do indicate a definite influence of engine power. Therefore, the regressions were calculated with as most relevant ones:

$FP = 0,111\ EP^{0,576}$ (rectangle 102-1968)
$FP = 0,135\ EP^{0,521}$ (rectangle 202-1968)
$FP = 0,070\ EP^{0,646}$ (rectangle 102-1969)

The estimates are significant, but none of the regressions give a direct proportionality between fishing power and engine power.

SUMMARY.

1. The relationship between fishing power and some vessel characteristics, viz. gross tonnage, engine power and length has been studied for Belgian beam trawlers fishing for sole in a small part of region IVc.

2. All the characteristics examined are significantly correlated with the fishing power, engine power however being the closest (table 2).

On the other hand, only correlations between fishing power and engine power remain significant after elimination of the effects of gross tonnage and length (table 4).

3. None of the regressions indicate a direct proportionality between fishing power and engine power.

4. The relationship between fishing power and engine power seems to be better represented by an exponential equation rather than by a linear one.

REFERENCES.

de Beer (F), 1970 - Comment on the use of tonnage certificate data as fishing power parameters - I.C.E.S. - Working Group on Fishing Effort.

de Boer (E.J.), 1970 - Comment on the use of engine power as a parameter for fishing power - I.C.E.S. - Working Group on Fishing Effort.

Gulland (J.A.), 1956 - On the Fishery Effort in English Demersal Fisheries - Fish. Invest. ser. II, vol. 20, number 5.

Table 1 - Characteristics of the vessels.

	Rectangle 102 - 1968 (n = 32)	Rectangle 202 - 1968 (n = 33)	Rectangle 102 - 1969 (n = 43)
Range			
GT	39,33 - 149,23	48,82 - 149,23	36,20 - 131,15
EP	130 - 480	145 - 480	130 - 450
L	15,95 - 30,68 m	17,46 - 30,68 m	14,51 - 26,30 m
Average			
GT	67,48	88,10	71,65
EP	259,47	329,36	277,88
L	19,78m	22,17 m	20,52 m

Table 2 (a) - Correlation-matrix of FP, GT, EP and L.
(ss = significant $p < 0,01$)

Rectangle 102-1968	FP	GT	EP	L
FP		0,480 (ss)	0,539 (ss)	0,480 (ss)
GT		1	0,818 (ss)	0,962 (ss)
EP			1	0,770 (ss)
L				1

Rectangle 202-1968	FP	GT	EP	L
FP	1	0,490 (ss)	0,557 (ss)	0,516 (ss)
GT		1	0,653 (ss)	0,876 (ss)
EP			1	0,664 (ss)
L				1

Rectangle 102-1969	FP	GT	EP	L
FP	1	0,643 (ss)	0,700 (ss)	0,624 (ss)
GT		1	0,766 (ss)	0,963 (ss)
EP			1	0,750 (ss)
L				1

Table 2 (b) - Correlation-matrix of log FP, log GT, log EP or log L
(ss = significant $p < 0,01$)

Rectangle 102-1968	Log FP	Log GT	Log EP	Log L
Log FP	1	0,576 (ss)	0,655 (ss)	0,580 (ss)
Log GT		1	0,803 (ss)	0,967 (ss)
Log EP			1	0,771 (ss)
Log L				1

Rectangle 202-1968	Log FP	Log GT	Log EP	Log L
Log FP	1	0,480 (ss)	0,575 (ss)	0,510 (ss)
Log GT		1	0,721 (ss)	0,852 (ss)
Log EP			1	0,681 (ss)
Log L				1

Rectangle 102-1969	Log FP	Log GT	Log EP	Log L
Log FP	1	0,646 (ss)	0,724 (ss)	0,622 (ss)
Log GT		1	0,775 (ss)	0,955 (ss)
Log EP			1	0,727 (ss)
Log L				1

Table 3 (a) - Partial correlation coefficients between FP and GT, EP or L.
(y = FP ; 1 = GT ; 2 = EP and 3 = L) (ss = significant $p < 0{,}01$;
s = significant $p < 0{,}05$)

	Rectangle 102-1968	Rectangle 202-1968	Rectangle 102-1969
$R_{y1.2}$ =	0,080	0,201	0,234
$R_{y2.1}$ =	0,290 (s)	0,358 (s)	0,421 (ss)
$R_{y1.3}$ =	0,077	0,092	0,201
$R_{y3.1}$ =	0,075	0,207	0,021
$R_{y2.3}$ =	0,303 (s)	0,334 (s)	0,449 (ss)
$R_{y3.2}$ =	0,120	0,236	0,210
$R_{y1.23}$ =	0,068	0,028	0,105
$R_{y2.13}$ =	0,301	0,323	0,421 (s)
$R_{y3.12}$ =	0,112	0,129	0,009

Table 3 (b) - Partial correlation coefficients between log FP and log GT, log EP or log L
(y = log FP ; 1 = log GT ; 2 = log EP and 3 = log L)
(ss = significant $p < 0,01$; s = significant $p < 0,05$)

	Rectangle 102-1968	Rectangle 202-1968	Rectangle 102-1969
$R_{y1.2}$ =	0,112	0,116	0,195
$R_{y2.1}$ =	0,394 (ss)	0,377 (s)	0,464 (ss)
$R_{y1.3}$ =	0,074	0,102	0,224
$R_{y3.1}$ =	0,110	0,219	0,023
$R_{y2.3}$ =	0,400 (ss)	0,362 (s)	0,506 (ss)
$R_{y3.2}$ =	0,157	0,198	0,202
$R_{y1.23}$ =	0,080	0,036	0,029
$R_{y2.13}$ =	0,401 (s)	0,351	0,467 (s)
$R_{y3.12}$ =	0,136	0,165	0,063

Table 4 (a) - Regressions : FP = a + bX (X = GT, EP or L)

(ss = significant $p < 0,01$; s = significant $p < 0,05$)

Rectangle 102 - 1968				
FP = 1,47277 + 0,01929 GT	(0,00550) (ss)	t = 3,505	R = 0,480	(F = 12,285) (ss)
FP = 1,18635 + 0,00612 EP	(0,00149) (ss)	t = 4,101	R = 0,539	(F = 16,814) (ss)
FP = -0,36540 + 0,15875 L	(0,04532) (ss)	t = 3,503	R = 0,480	(F = 12,269) (ss)
Rectangle 202 - 1968				
FP = 1,39240 + 0,01612 GT	(0,00515) (ss)	t = 3,131	R = 0,490	(F = 9,801) (ss)
FP = 1,18777 + 0,00493 EP	(0,00132) (ss)	t = 3,730	R = 0,557	(F= 13,914) (ss)
FP = -0,03485 + 0,12844 L	(0,03827) (ss)	t = 3,356	R = 0,516	(F = 11,263) (ss)
Rectangle 102 - 1969				
FP = 1,19759 + 0,02052 GT	(0,00446) (ss)	t = 4,604	R = 0,643	(F = 21,199) (ss)
FP = 0,89026 + 0,00640 EP	(0,00119) (ss)	t = 5,368	R = 0,700	(F = 28,816) (ss)
FP = -0,53094 + 0,15589 L	(0,03563) (ss)	t = 4,375	R = 0,624	(F = 19,145) (ss)

Table 4 (b) - Regressions : $\log FP = \log a + b \log X$ (X = GT ; EP or L).

(ss = significant $p < 0,01$; s = significant $p < 0,05$)

Rectangle 102-1968

$$\log FP = -0,44705 + 0,48177 \log GT$$
(0,10670) (ss)
$t = 4,515$
$R = 0,576$
($F = 20,386$) (ss)

$$\log FP = -0,95596 + 0,57619 \log EP$$
(0,10393) (ss)
$t = 5,544$
$R = 0,655$
($F = 30,737$) (ss)

$$\log FP = -1,10866 + 1,18330 \log L$$
(0,25949) (ss)
$t = 4,560$
$R = 0,580$
($F = 20,794$) (ss)

Rectangle 202 1968

$$\log FP = -0,49563 + 0,48185 \log GT$$
(0,15799) (ss)
$t = 3,050$
$R = 0,480$
($F = 9,302$) (ss)

$$\log FP = -0,86914 + 0,52120 \log EP$$
(0,13310) (ss)
$t = 3,916$
$R = 0,575$
($F = 15,334$) (ss)

$$\log FP = -0,94225 + 1,02606 \log L$$
(0,31086) (ss)
$t = 3,301$
$R = 0,510$
($F = 10,895$) (ss)

Rectangle 102 - 1969

$$\log FP = -0,62108 + 0,56119 \log GT$$
(0,12104) (ss)
$t = 4,636$
$R = 0,646$
($F = 21,496$) (ss)

$$\log FP = -1,15787 + 0,64598 \log EP$$
(0,11225) (ss)
$t = 5,755$
$R = 0,724$
($F = 33,115$) (ss)

$$\log FP = -1,18213 + 1,21249 \log L$$
(0,27860) (ss)
$t = 4,352$
$R = 0,622$
($F = 18,940$) (ss)

FIGURE 1 - COASTAL FISHING AREA (rectangles 102 and 202)