THE COST OF CAPITAL IN FISHERIES[1]

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Abstract

The cost of capital, as an opportunity cost, is of wide applicability across microeconomics and economic policy. The concept is relatively simple; it is the return, implicitly an interest rate, on the next best risk-free investment. An alternative is the global marginal productivity of capital, assuming that capital markets are efficient. It equates to the world growth rate. However, several factors cloud what this figure is. This paper formulates a novel method to estimate the opportunity cost of capital, ex post, and applies it in a challenging industrial case study; namely to the fishing fleets of 19 OECD member states, whose results and attendant inferences are discussed.

Keywords: Fisheries, Capital, Profitability

JEL Codes: Q22, D24, E22

THE COST OF CAPITAL IN FISHERIES

To estimate the long term (economic) profitability of enterprises in fisheries, and of a fishery in total, a measure of the cost of capital in necessary. The profitability of a fishery indicates whether the fishery is well-managed or is being overfished. It is used, for example, in the European Union's (EU) series of Annual Economic Reports on the EU Fishing Fleet (STECF 2020 and earlier, and see Carvalho 2020). Those reports currently use a variety of static annual interest rates based on a five year average of the rate on European Central Bank 5% bonds with the Harmonised Index of Consumer Prices deducted.

Strictly, the (opportunity) cost of capital (OCC) is the return foregone from investing internally rather than in a risk-free external alternative investment. Davenport (1911) referred to it as "*These displacements of possible products, these foregoings of alternative openings, these sacrifices of some second thing in the process of getting some particular thing, are perhaps best indicated under the term opportunity cost*". In practical terms this alternative is usually taken to be long term government bonds where it is assumed that there is a secondary market providing perfect liquidity and there is no risk of default. This implies that an estimate of the OCC may be inferred by manipulation of the capital market schedule (Sharpe 1970).

Friedman (1990) explains that an equilibrium representing the OCC will develop because investors will choose the better return against the poorer. In the short run, this creates excess demand for the better investment lowering its return, and lower demand for the poorer, raising its return until an equilibrium occurs where all projects offer the same. This equilibrium return is another interpretation of the OCC.

The return on long term government bonds is the yield in real interest achieved; strictly, the coupon rate of interest divided by the purchase price of the bonds and with the rate of inflation subtracted from the result:

$$Real\ Rate\ of\ Interest = \frac{Coupon\ Rate\ of\ Interest\ on\ Bond}{Price\ of\ Bond} - Rate\ of\ Inflation$$

A problem with this definition is that current and future rates of inflation are unknown, government statistics giving only a historic rate over a recently ended period. At the putty stage of investment decisions (Bischoff 1968) this renders the real rate of interest speculative and dependent on expectations. Dixit and Pindyck (1994) assert that there is considerable anecdotal evidence that firms make investment decisions based on an expected OCC which is higher than that predicted by the capital asset pricing model (Sharpe 1970). An example is hurdle rates; rates which require a minimum expected return accounting for the degree of risk present. However, all these current methods to estimate the opportunity cost are lacking.

The reader should separate in their mind the difference between *ex post* estimates of the authenticable OCC where factors such as the rate of inflation can (within the limits of survey accuracy) be accounted for and the *ex ante* expected OCC which is prey to a host of unknowns.

In this paper we begin with a review of the literature on the marginal productivity of capital (MPK). This will be followed by an assessment of how it departs from reflecting the OCC. We will describe a method of estimating the OCC appropriate for use across borders. This method is applied in a case study of the fishing fleets of 19 Organization for Economic Co-operation and Development (OECD) countries and the results discussed. Fisheries have been chosen because of the difficulties associated with investment in producing output from a self-renewing resource, difficulties which challenge the simple virtues of many industrial investments. The influence of the OCC on the incentive to overinvest in productive capacity to the detriment of the natural resource is topical, but the question remains of wide applicability in economic policy. The case study thus tests the concept of OCC beyond what has traditionally been its normal province.

I. Review of Literature

The OCC guides private and public investment decisions to determine whether the returns to society are positive or negative over the lifespan of an investment. Measures of the OCC concentrate on private investments. The OCC, which is the focus of this paper, is utilized in our case study to assess long-term profitability in indicators such as return on investment or return on fixed tangible assets.

In a perfectly competitive world where capital markets have no distortions, the OCC should approximate to the MPK. However, the world is not perfectly competitive and capital markets experience market failures as agents do not hold perfect information on future prices and economic conditions (Howarth and Norgaard 1993). Estimating the appropriate rate for the OCC is crucial for the allocation of resources; too high and socially desirable projects may not be undertaken, too low and there is a risk of economically inefficient, that is to say, wasteful, investment (Zhuang et al. 2007). Where inefficient regimes fail to internalize the externality present in common pool resources such as the earth's atmosphere, rain forests and fisheries, *inter alia*, too low an OCC will tend to over-exploitation where there is sufficient demand.

Baumol (1968) noted that; "*There are important externalities and investments of the public goods variety which cry for special attention…Investment in the preservation of such items then seems perfectly proper, but for this purpose the appropriate instrument would appear to be a set of selective subsidies rather than a low general discount rate that encourages indiscriminately all sorts of investment programs whether or not they are relevant".*

Recent studies have shown similar estimates for the MPK across countries. Caselli and Feyrer (2007) summarized the methods of assessing the MPK as; cross country comparison of interest rates, regressing the change of yields on capital with the change of capital stock, and calibration (in other words, choosing a functional form for the relationship between physical capital and output and careful accounting for complementary factors). Using the third method (accounting for price and natural capital adjustments) they found no statistical difference in MPK between developed and developing countries (i.e. the world's capital stock is efficiently allocated across countries). Rates of return were found to be 8.4% for developed countries and 6.9% for developing countries, with standard deviations of 1.9% and 3.7% respectively. Coppola, Fernholz, and Glenday (2014) estimated the economic OCC for public investments in Mexico at 10%.

The OCC is time-indifferent. A glance at the Wall Street Journal or the Financial Times shows the rates at which funds can be lodged overnight. The term-structure of interest rates is due to the variability of other influences, such as risk and hedging pressure and not the intrinsic cost of capital itself.

Clark and Munro (2017) suggest that viewing natural resources as public assets means investment in these resources (in terms of conservation) is public and hence the social rate of return is the appropriate measure of return from the investment. They suggest that the economics of fisheries investment programs is an important area of research to be developed while noting "*The economics, let it be conceded from the outset, is daunting, because sweeping generalizations become highly suspect*". (Clark and Munro 2016).

II. On the use of interest rates and bond yields

Schaefer showed that all constant coupon yield curves are asymptotic to the perpetuity yield and therefore asymptotically horizontal (Schaefer 1977). They tend to the constant OCC over infinitely long terms to maturity. However, estimates of this asymptotic constant are difficult to find. Bartholomew (2016) asserts that "*The yield on 10-year* [UK] *government bonds is a mere 2.5pc. That is peanuts. If inflation runs at 2pc, as it is meant to, then the reward will be barely anything at all.*" However, he omitted to acknowledge that inflationary expectations in the UK at the time were currently running close to 0%, revealing a yield close to the long run OCC.

In terms of the capital input, the influence of expectations is paramount. The question the investor in capital equipment will ask is: will the return received from investing be greater than that received if the funds are placed in a risk-free investment (usually taken to be government bonds, date to maturity of ten years or more issued by a country with as highly stable political and economic conditions as it is possible to envisage)? If the answer is yes then the investment will be made, if no, then the investment will not proceed but it is clear that the decision is based on a judgement of the future expectations. The point of indifference will reflect the OCC that we are seeking.

In association with expectations but supplementary to it, the OCC will be obscured when a risk premium is demanded within the going interest rate. This will reflect the chances of expectations not being achieved. Such a risk will be raised by less stable political and economic conditions. Risk premium includes an accommodation for the issuing government and may partly explain considerable differences in government bond rates between the European Union Member States (see Figure 1).

A further problem is that while it is possible to try to remove these factors by using a seemingly risk-free bond, safe bonds can easily become unsafe owing to unpredictable political changes; oil supply and price crises, trade wars and Brexit are among the recent examples.

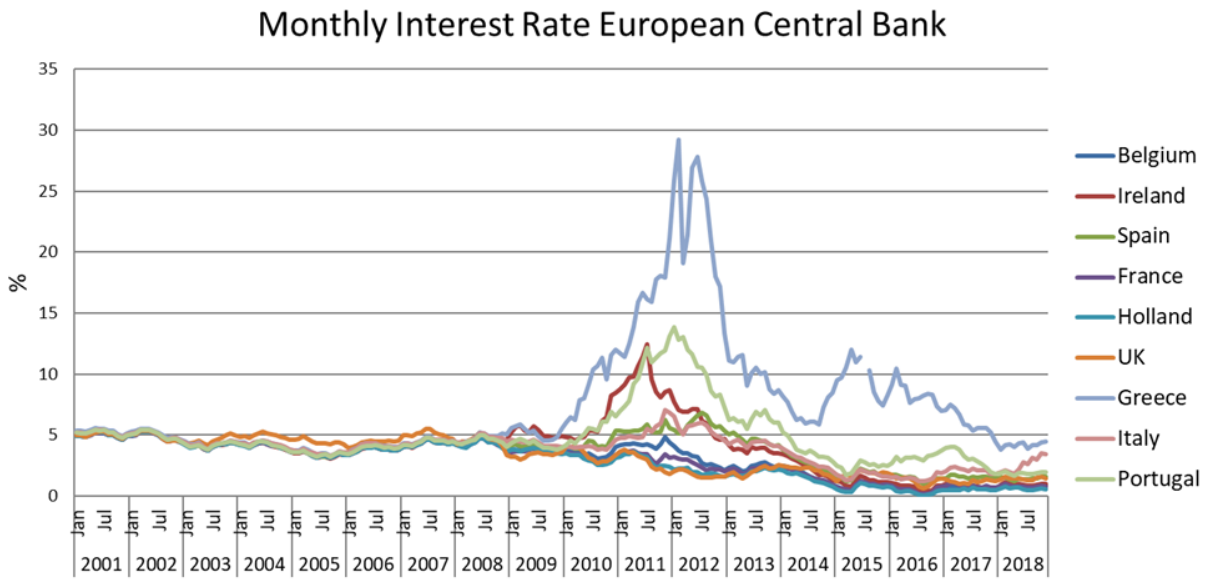

FIGURE 1. MONTHLY NOMINAL INTEREST RATE FOR SELECTED EU MEMBER STATES 2001-2018.

Source: European Central Bank

Theory holds that the OCC is equal to the MPK, since the MPK represents to locus of indifference between investing and not investing and therefore the demand curve for investment capital. Unfortunately, the MPK is difficult to calculate and is not readily observable, a desirable characteristic for the OCC. However, it will equal the expected real growth rate in a competitive market economy and this may serve as a reasonable proxy. Since the chance to invest in an alternative is not restricted by industrial sector the MPK is the growth rate of the domestic economy. If financial markets were perfectly efficient there would be no delimitation by national boundaries. Hence, for practical purposes Gartner's view that the OCC is equal to the long run growth rate of an economy may be deemed to hold (Gartner 2003).

In Figure 2 the GDP growth rates for the world and the EU are shown since 1985 in part (a) and at 10, 20 and 30-year timespans up to 2008 and since 2008 in part (b). In each timespan leading up to 2008 global growth rates surpassed 3% with the EU growth rate surpassing 2%. Clearly growth rates have been impacted since 2008, especially in the EU. The IMF has estimated world growth in 2017 at 3.8% and the forecast for 2018 and 2019 is 3.9% (IMF 2019).

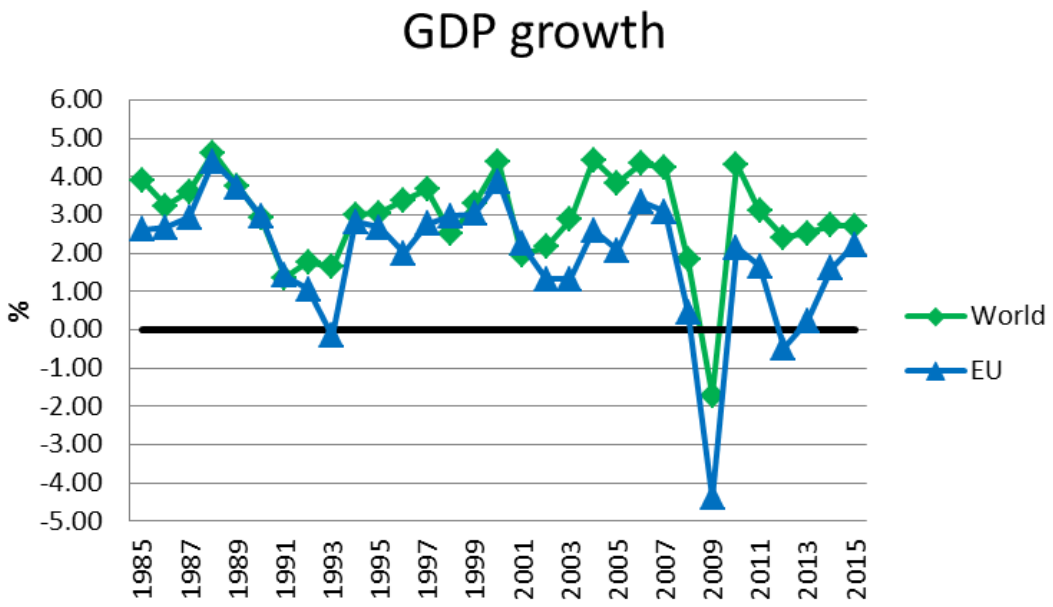

FIGURE 2. ANNUAL GROSS DOMESTIC PRODUCT (GDP) GROWTH RATE OF THE WORLD AND EU ECONOMIES

Source: World Bank World Development Indicators

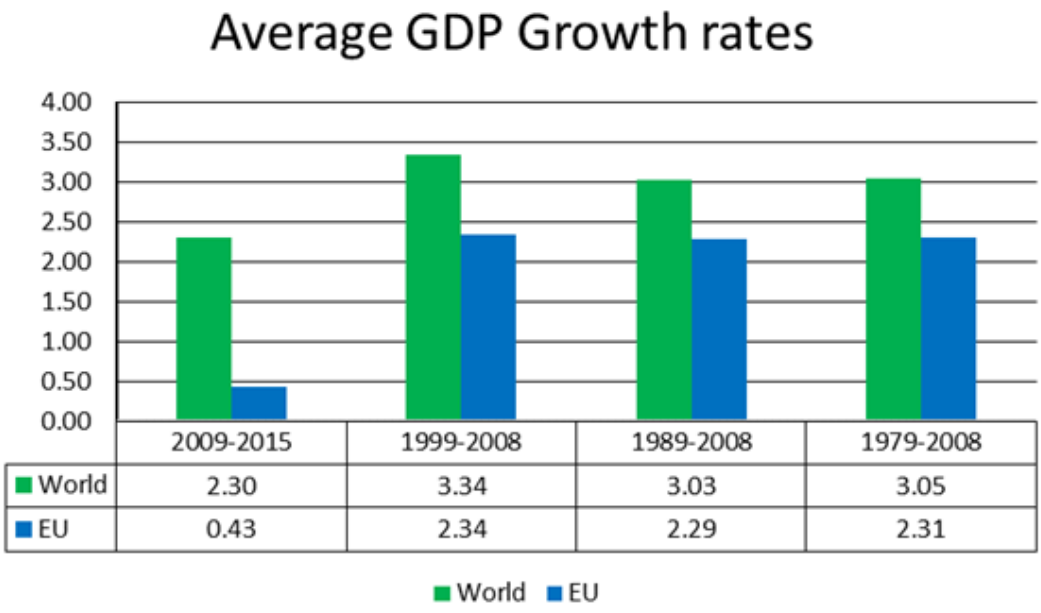

FIGURE 3. AVERAGE GROSS DOMESTIC PRODUCT (GDP) GROWTH RATE OF THE WORLD AND EU ECONOMIES

Source: World Bank World Development Indicators

The extreme examples within the Eurozone shown in Figure 3, with *de facto* defaults, show that there is an underlying OCC. Where default or risk of default occurred, rates on the markets rose to relatively high levels reflecting the risk premium, not the underlying return.

III. The model

In order to estimate the OCC for the fisheries, we propose a method to estimate OCC that we believe is superior to those currently being used.

Using a case study, we adapt Sharpe's capital asset pricing model (Sharpe 1970). The capital asset pricing model has considerable theoretical limitations and a poor empirical performance, but it is mathematically rigorous (Fama and French 2004). Empirical performance relates to *ex ante* forecasts based on expectations whereas in this paper it is being considered as a means of measurement *ex post* when outcomes are known. Sharpe's capital market schedule in the capital asset pricing model holds that

(1) $$E(R_p) = R_i + \frac{\sigma_p[E(R_m) - R_i]}{\sigma_m}$$

where $E(R_p)$ is the expected return on an investment; R_i is the riskless rate of interest (or OCC); R_m is the expected return on a market portfolio (which may be taken to be the MPK), and the σ are the standard deviations. Equation (1), the capital market line, is intended for use in calculating the risk premium under the assumption that the riskless rate of interest, R_i, is known. However, data are available for the remaining variables, the return on investment, R_p, and the MPK, R_m, so it is possible to estimate the riskless rate of interest.

In a fishery, these variables serve as the expected return on the investment in fishing, $E(R_p)$, and the world growth rate, $E(R_m)$, with the accompanying standard deviations. This assumes the efficient market hypothesis applies (Fama 1970); notably that there are no cross-border inefficiencies in the money markets.

Re-arranging (1) therefore gives the OCC as

(2) $$R_i = E(R_p) - \frac{\sigma_p[E(R_m) - R_i]}{\sigma_m}$$

and

(3) $$\sigma_m[R_i] = \sigma_m[E(R_p)] - \sigma_p[E(R_m) - R_i]$$

(4) $$\sigma_m[R_i] = \sigma_m[E(R_p)] - \sigma_p[E(R_m)] + \sigma_p[R_i]$$

(5) $$\sigma_m[R_i] - \sigma_p[R_i] = \sigma_m[E(R_p)] - \sigma_p[E(R_m)]$$

(6) $$R_i(\sigma_m - \sigma_p) = \sigma_m[E(R_p)] - \sigma_p[E(R_m)]$$

(7) $$R_i = \frac{\sigma_m[E(R_p)] - \sigma_p[E(R_m)]}{(\sigma_m - \sigma_p)}$$

The difficulty with Equation (7) is that the parameters are largely unknown and so an approach from a different direction is necessary. Equation (8), working from empirically available data, was applied to the national fisheries of the United Kingdom and of the Republic of Ireland in two case studies. The real rate of growth of the national value of landings, TR_{real}, was determined from

(8)

$$\frac{dTR_{real}}{dt} = \frac{dTR_{nominal}}{dt} - \frac{dRPI}{dt}$$

where $TR_{nominal}$ is the observed value of the national output (landings) of fish and *RPI* is the index of domestic retail prices.

Over the period 1994 to 2016 Equation (8) was found to have a mean of -0.027 and a standard deviation of 0.158 for Ireland with -0.001 and 0.086 for the UK. The real rate of growth of world output was found similarly from World Bank data for world real growth.

(9) $$\frac{dReal\ World\ Output}{dt} = \frac{Real\ World\ Output_t}{Real\ World\ Output_{t-1}} - 1$$

This was found to have a mean of 0.030 and a standard deviation of 0.013 over the period.

Applying Equation (7) and the data from Equation (8) and Equation (9) to the fisheries of the national fleet in the Republic of Ireland gives a figure of 2.95%. The comparative figure for the United Kingdom fleet is 3.50%. The time series used are mined from the Sea Fisheries Statistical Tables and the Retail Prices Index published by the UK government, and from data published by Bord Iascaigh Mhara and the Central Statistical Office for Ireland. World output and inflation data was obtained from the World Bank website.

To analyze the results of this method in more depth, the method was applied to further fleets using historical data (available from 1995-2016) from the OECD on the value of landings for the following 17 additional countries; Denmark, Germany, Portugal, France, Spain, Finland, Netherlands, Iceland, Australia, Norway, USA, Turkey, Mexico, Japan, South Korea, Thailand and Greece. The results demonstrate a degree of consistency, lying as they do between 3% and 5% across countries, as can be seen in Figure 4. Efficient market theory suggests that they should be identical – not something likely to be found in the real world.

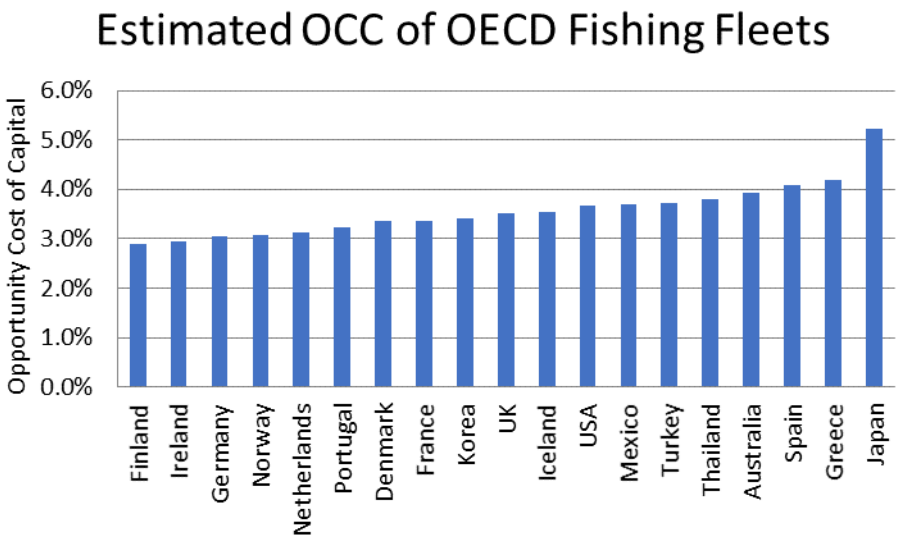

FIGURE 4. THE ESTIMATED OPPORTUNITY COST OF CAPITAL FOR SELECTED OECD FISHING FLEETS

IV. Results

The results of the case study show that the fishing fleets of Finland, Ireland and Germany have the lowest OCC with rates of 3% or below. Of the 19 fleets assessed all but Japan have an OCC roughly between 3 and 4%. The UK fleet lies around the mid-point with an OCC of 3.5%. Uniquely in terms of the selection here, the Japanese economy showed an average inflation rate of 0% for the period 1995-2016 which may explain its higher OCC. The differences in OCC shown for this set of countries are statistically significant at the 99% confidence level ($p = 3.839E-09$). The failure apparently to confirm the presence of efficient markets may be attributable to several factors. First, we have assumed that the actual level of inflation equaled the expected inflation. Friedman (1977) noted that, though rational expectations have come to be generally accepted in economic theory, the adaptive expectations hypothesis still has some credence with respect to adjustment of inflationary expectations. A second source of market failure might be that investors in fishing may be remote from the capital markets, violating the assumption of perfect knowledge.

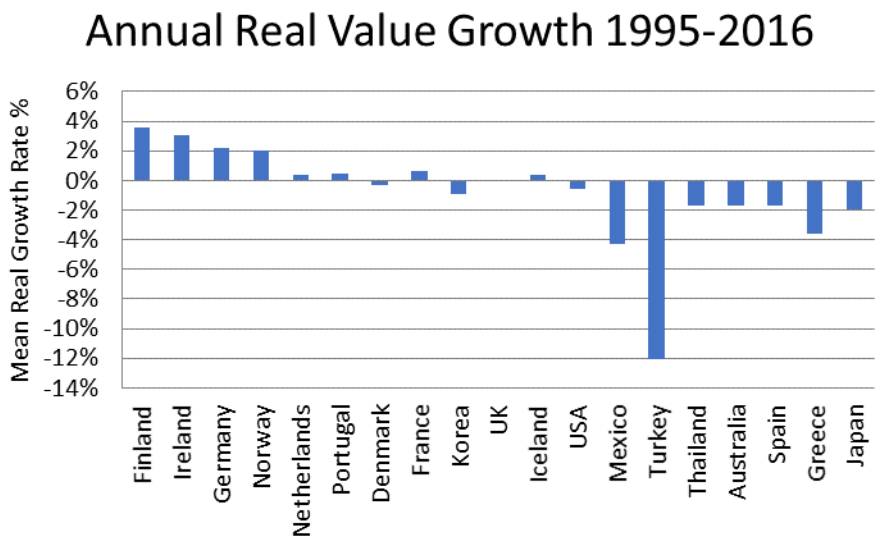

FIGURE 5. THE MEAN REAL ANNUAL VALUE GROWTH RATE FOR SELECTED FISHING FLEETS (1995-2016)

In Figure 5 the mean annual real growth per fishing fleet is shown for the whole 22-year series and clearly demonstrates the negative correlation with OCC. The fleets with the highest real annual growth are generally the ones with the lowest OCC and vice versa. The steep declines in real growth for the Mexican and Turkish fleets are due to the high inflation rates experienced in the former country during the 1990's and in the latter country throughout most of the time series.

V. Discussion

The method developed in this paper allows estimation of OCC for individual countries and separately for individual sectors within countries. The results demonstrate the inefficient distribution of capital globally and locally.

This is valuable because the method accounts for the historical behaviour of the fishing industry alongside the trajectory of the national economy. This indicates whether the industry is generating a return on investment that is superior to alternative investment opportunities. Therefore, this method captures the definition of OCC for the first time, as far as the authors are aware.

In practical terms, the implications can affect policy-making and impact financially on fleets and vessels through impeding their access to public funds, as can be seen in the EU context from the case study presented here.

Clark and Munro's (2016) suggestion of using a broad brush common 3.5% given in their keynote address but not repeated in the associated paper (Clark and Munro 2016) is drawn from the Green Book issued by the British Government to advise on recommended practice for cost benefit analysis (HM Treasury 2011) and is its perception of the social time preference rate of discount. It refers to projects with a lifespan of below 30 years but as can be seen from the date of publication, is somewhat inflexible. In addition to this, the timespan must be considered in terms of the intra-generational impacts.

Capital gains on the Dow Jones Industrial Average have been 1.6% per year over the period 1910-2005. Dividends have increased the total "real" return on equities to 3.2% on average. This aligns very closely with the suggested rate of Clark and Munro and the results of the adapted capital asset pricing model described in this paper. According to these results the OCC of the UK, which is around the median value of the 19 fishing fleets analysed, aligns perfectly with Clark and Munro's suggestion. However, the variation in OCCs across countries suggests that either there is a misallocation of capital or that there are further national factors which have not been identified.

The results nevertheless show statistically significant differences in OCC for these fleets which span the developed and developing worlds. The model used assumes market efficiency and they therefore suggest there are some inefficiencies within capital markets globally the further away in structural terms the investor is from the market.

Strictly speaking the OCC should be driven by the marginal product of capital. This raises two problems; first, whether investors are sufficiently close to international money markets to overcome market failures due to imperfect knowledge, and secondly, the problem of forecasting the future. These lead us to conclude that there will be differences in the OCC between countries and that expectations are no more than a best

guess of the future. However, the IMF has estimated world growth in 2018 at 3.7% and the forecast for 2019 is 3.5% rising to 3.6% in 2020 (IMF 2019). It is worth noting that the IMF has made a succession of slight revisions downwards to its forecasts, reflecting the cooling in the world economy and difficulty introduced by expectations in measuring the OCC and its proxy, the world growth rate.

VI. Conclusion

In response to these considerations, we conclude that the figure of a real rate for the OCC should reflect the long-term trend in the real growth rate of the world economy. This applies generally and includes the fisheries of our case study. Any local factors, such as a history of difference from the growth rate of the world economy could then be considered but must be justified. The researcher working on historic data is in a better position, since the annual growth rates of (entire) domestic economies are known and can be used as the proxy. The OCC is not fixed over time. The case studies for the OECD member state fleets suggest that the money markets still exhibit inefficiencies, as is only to be expected, and for practical purposes such a limitation must be recognized. Thus, the OCC could be calculated for each country using Equations (7), (8) and (9) in order to recognize the presence of the remaining limited market inefficiencies. If this is done then the local OCC may be expected to vary from the global figure, reflecting the cost of the inefficiencies.

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