Implicit discount rates and fisheries management: is there a relationship?

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Abstract:
Fishers are faced with multiple risks, including unpredictability of future catch rates, prices and costs. While the latter are largely beyond the control of fisheries managers, effective fisheries management should reduce uncertainty about future catches. Different management instruments are likely to have different impacts on the risk perception of fishers, and this should manifest itself in their implicit discount rate. Assuming licence and quota values represent the net present value of the flow of expected future profits, then a proxy for the implicit discount rate of vessels in a fishery can be derived by the ratio of the average level of profits to the average licence/quota value. From this, an indication of the risk perception can be derived, assuming higher discount rates reflect higher levels of systematic risk. In this paper, we apply the capital asset pricing model (CAPM) to determine the risk premium implicit in the discount rates for a range of Australian fisheries, and compare this with the set of management instruments in place. We test the assumption that rights based management instruments lower perceptions of risk in fisheries. We find little evidence to support this assumption, although the analysis was based on only limited data.

Paper presented at the 54th Annual AARES National Conference
Adelaide, South Australia, February 10-12, 2010

1. Introduction

Fisheries are characterised by relatively high levels of uncertainty. Environmental fluctuations can affect both the availability and distribution of the fish stocks. Given that fishing activity is based on the pursuit of an unseen fugitive resource, catches are a result of both luck and skill of the fisher in reading and interpreting the environmental conditions. Technological developments can help improve the skill component by substituting knowledge and instinct with gadgetry, reducing the difference between the best and average fisher. However, day-to-day catches still involves a large random component.

Fisheries management can also influence risk and uncertainty in fisheries. In open access fisheries, the number of potential competitors for the limited resource is variable, and incentives to race to fish exist as a result of the potential for lower future catches due to overexploitation. The introduction of limited entry reduces the level of uncertainty regarding the number of potential competitors, but each competitor generally has little incentive to conserve the resource due to their inability to limit the catches of their counterparts. The introduction of rights based management measures, particularly individual quotas, is generally considered to reduce the incentive to race to fish. Under such systems, the total allowable catch (TAC) as well as the individual fishers' shares are known, and fishers can concentrate on when and how to catch their share with a reasonable degree of certainty that their share will be available.

A link between the level of uncertainty inherent in a fisheries management system and the fishers' discount rate is often assumed in the fisheries economics literature. Under highly competitive conditions (open access or limited entry), fishers are generally assumed to have relatively high discount rates (e.g. Curtis 2002). In contrast, the introduction of rights based management systems is believed to result in lower discount rates as fishers adjust their relative time preferences and uncertainty about future catches decreased (e.g. Grafton 1996; Asche 2001; Alcock 2006).

Empirical testing of this assumption has been limited, and is largely part of the body of perceived wisdom relating to fisheries economics. Asche (2001) found some evidence that discount rates decreased as an individual transferable quota (ITQ) program became established over time, although Hannesson (1996) found that high discount rates persisted for some time under ITQ programs. In contrast, Newell et al (2005) found that implicit discount rates were roughly equivalent to the risk free rate in New Zealand fisheries where ITQs are well established.

In this paper, we examine the relationship between the implicit discount rate and the type of fisheries management using a cross section of Australian fisheries with varying management regimes. We apply a variant of a finance-based model – the capital asset pricing model (CAPM) – to estimate the relative risk premium associated with each fishery, reflecting its level of undiversifiable risk (systematic risk). We use panel data methods to estimate the risk premium, with slope and intercept shifting dummy variables to determine the impact of management on the risk perceptions in the different fisheries.

2. Methodology

In theory, licence values represent the discounted value of expected future economic profits in the fishery (Arnason 1990; Batstone and Sharp 2003). Assuming that expectations of future economic profits are based on current returns, then we would assume that licence values would be given by:

$$L = \frac{E(P)}{i} = \frac{R - V - F - iK}{i} \quad (1)$$

where *L* is the licence value, *P* is the level of economic profit, *V* is the total cash variable costs, *F* is the fixed costs (including economic depreciation), *K* is the capital value of the vessel and gear, and *i* is the discount rate (equivalent to the opportunity cost of capital). Given this, the implicit discount rate can be given by:

$$i = \frac{R - V - F}{(L + K)} \quad (2)$$

which is equivalent to the rate of return on total capital (vessel, gear and licence).

Most industries have a risk premium associated with their discount rate reflecting the relative level of risk associated with the investment. This premium increases and decreases in proportion to the relative level of risk, and may represent either a fixed premium or a proportion premium over and above the risk free discount rate. That is:

$$i = \alpha + \beta r + \varepsilon \quad (3)$$

where a represents α fixed risk premium, β represents a proportional risk premium, *r* is the risk-free interest rate and ε is a random error that represents divergences from the relationship in any one particular time period.

The measurement of risk premiums is a well developed area in the finance literature. The traditional model used is the capital asset pricing model (CAPM) (Sharpe 1964; Lintner 1965). The intuition behind the model is relatively straight forward. Risk and return is expressed as a linear relationship where the higher the level of systematic risk of an asset the greater its return. The model is expressed in terms of deviations from the risk-free rate of both the firm being examined as well as the market rate of return (representing an opportunity cost of capital). The CAPM assumes that:

$$i - r = \alpha + \beta(m - r) + \varepsilon \quad (4)$$

where *m* is the market rate of return. The beta value (β) represents the systematic risk of a firm divided through by the total risk of the market portfolio (all systematic risk). It is therefore an index of the firm's risk relative to total market risk, commonly referred to as the risk premium. A beta value greater than 1 (resulting in a higher expected required rate of return) would therefore indicate that the firm has an inherently greater risk than that of the market. In a financial context, a further interpretation of beta is that high share beta (>1) will tend to outperform the market return (underperform for low betas <1) when the market return is rising. If beta is equal to one, the firm's risk and return is equivalent to the market risk and return. An assumption of the CAPM model is that $\alpha=0$. Values of $\alpha>0$ or $\alpha<0$ suggest that some other factor (in addition to systematic risk) is explaining the assets rate of return.

The linear relationship is based on the assumption that the market only rewards risk that cannot be diversified away by holding a well diversified portfolio of assets. Systematic, or non-diversifiable risk, is generally summarised in most key financial texts as related to the sensitivity of a firm's revenues to macroeconomic factors, its proportion of fixed to variable costs and the level of financial gearing (see

Copeland and Weston 1992; Brealey et al 2000). In the context of fisheries, management is effectively a component of the macroeconomic environment in which the vessels operate.

The empirical estimation of rates of return using either CAPM or its variants in natural resources has largely been confined data rich resource industries including mining (e.g. McClain et al 1996; Cairns 1982), timber (e.g. Sadorsky and Henriques 2001) and agriculture (e.g. Gu 1996). Of these, agricultural applications are likely to be a more relevant comparator to fisheries. Earlier studies in the US generally concluded that agriculture had a higher than expected risk premium (Barry 1980; Irwin 1988), while later studies concluded that the estimated risk associated with agricultural assets was low (Bjornson and Innes, 1992; Arthur et al. 1998), possibly reflecting changes in agricultural policy. In the UK, Gu (1996) found that risk premiums varied depended on farming type, although in all cases the beta values were less than one and in most cases less than 0.5, possibly a reflection of the protection given to these industries under the European common agricultural policy.

Examples of use of the CAPM model in fisheries are limited. Newell et al (2005) found that the β coefficient reflecting the risk of holding New Zealand fishing quota relative to the New Zealand stock market was not statistically different from zero, suggesting little undiversifiable risk associated with holding fishing quota. This also implies that the appropriate discount rate for the industry is close to the risk-free rate.

3. Data

Financial performance indicators for Australian fisheries are limited. However, information on rates of return to capital were available for a number of fisheries over the period 1992-93 to 2007-08 (Table 1), based on economic surveys conducted by ABARE (Commonwealth fisheries) and EconSearch (South Australian fisheries).[1] Data were not available for each fishery in each year. The main management measure in place each year was also derived from management reports and survey reports. While many variations in management types exist, and changes within these types occur over time, management was classified as either non-transferable input controls (limited entry, closures, gear restrictions etc); individual transferable effort quotas (ITEs – tradeable days at sea, gear units etc) and individual transferable catch quotas (ITQs) (Table 1). The set of available data resulted in most of the three types of management being represented in each year of the data (Table 2), with a total of 164 observations

For most Commonwealth fisheries, economic surveys were conducted every second year, although licence values were estimated only for the year of the survey (resulting in every other year being unusable). Changes in fishery definition and reporting over time also resulted in incomplete data series for each fishery. For example, the south east trawl, south east non-trawl and southern shark fisheries were merged into the Southern and Eastern Scalefish and Shark Fishery (SESSF) over the period of the data. Earlier surveys reported on these fisheries separately, and disaggregated the fisheries into sub-components (e.g. Danish seine, inshore and offshore trawlers). More recent surveys reported only a combined trawl sector and gillnet hook and trap sector. For the South Australian fisheries, a more consistent continuous data series was available, although for some fisheries data were only available for the more recent years.

[1] These data were extracted from a number of different survey reports available on the respective organisations websites: www.abare.gov.au and www.econsearch.com.au.

Table 1. Fishing sectors included in the analysis and their management over the period of the data

Fishery	Non-transferable Input controls	ITE	ITQ
Commonwealth fisheries			
Commonwealth trawl sector (combined)			X
Danish seine			X
Inshore Trawl boats			X
Offshore Trawl boats			X
Gillnet (shark boats)	X		X
Gillnet, hook and trap (combined)	X		X
Hook and trap (non trawl)	X		X
Eastern tuna and billfish fishery	X		
Northern Prawn Fishery	X	X	
Torres Strait Prawn Fisheries		X	
South Australian fisheries			
Abalone fishery			X
Blue Crab fishery			X
Gulf St Vincent Prawn Fishery	X		
Spencer Gulf and West Coast Prawn Fishery	X		
Lakes and Coorong Fishery	X		
Northern Zone Rock lobster	X		X
Southern Zone Rock lobster			X
Sardine fishery			X
Scalefish fishery	X		

Table 2. Distribution of management types over the period of the data

Financial year[a]	Non-transferable Input controls	ITE	ITQ	Total
1993	1	0	4	5
1994	2	1	3	6
1995	0	1	0	1
1996	1	1	4	6
1997	2	0	0	2
1998	6	1	6	13
1999	6	0	4	10
2000	5	1	7	13
2001	5	0	4	9
2002	4	2	8	14
2003	6	0	8	14
2004	5	2	9	16
2005	5	2	9	16
2006	5	2	7	14
2007	5	2	7	14
2008	4	2	5	11
Total	62	17	85	164

a) e.g. the year 1993 refers to 1992-93 etc

4. Analysis and Results

4.1 General trends in rates of return

The distributions of rates of return for the different fisheries are illustrated in Figure 1. Fisheries are grouped by their main management measures. From Table 1, several fisheries had periods of input controls prior to adopting ITQs as a main management measure. The rates of return for these fisheries were not separated out by management measure due to the limited data. However, these fisheries are grouped separately in Figure 1. From Figure 1, it appears that the average rates of return – the assumed measure of the implicit discount rate – are generally higher for ITQ fisheries than input control fisheries, although given the distributions around the means these differences are not statistically significant.

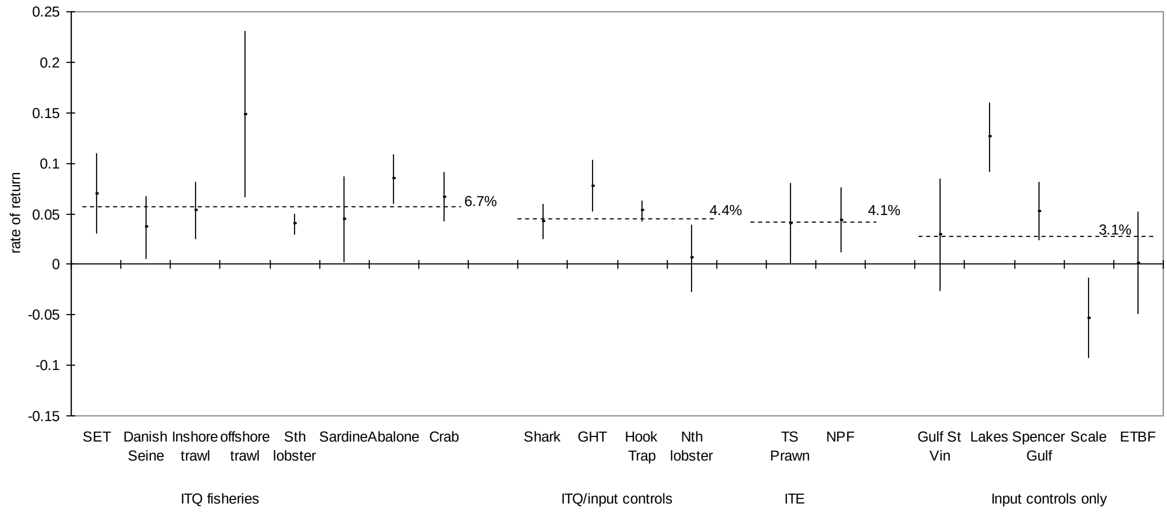

Figure 2. Rates of return for each fishery over the period of the data

While rates of return were apparently higher in ITQ fisheries, the interannual variation in these rates was substantially lower than other forms of management (Table 3). These suggest that ITQs either create greater stability in the fishery in terms of economic performance, or that licence/quota values are quicker to adapt to changes in average performance. This may be the case if licence values in input control based fisheries are more indicative of option value rather than reflect the discounted future returns in the fishery.

Table 3. Average rates of return by management type

Management type	Average rate of return	Average coefficient of variation
ITQ fisheries	6.7%	55%
Input/ITQ	4.4%	174%
ITE	4.1%	88%
Input only	3.1%	1367%

4.2 Econometric analysis

The introduction of rights based management is generally believed to result in a longer term perspective being adopted by the industry. Consequently, it would be expected that the β value in fisheries with some form of rights based management would be lower than that in command and control fisheries.

Most financial studies estimate the CAPM model to derive β values for each individual investment. However, given the sparsity of data available for the analysis for each fishery, the CAPM model was estimated using a panel data modelling approach.[2] An advantage of this was that the effects of management on α and β could be derived directly through the incorporation of management specific dummy variables into the analysis, such that:.

$$i_{j,t} - r_t = \alpha_o + \sum_k \alpha_k D_k + \left(\beta_0 + \sum_k B_k D_k \right)(m_t - r_t) \quad (5)$$

[2] A similar approach was also adopted by Cheng et al (2005) to estimate industry-wide effects.

Where D_k are a set of dummy variables representing different management interventions, k, the subscript j represents the fishery and t represents the year. As noted previously, given the limited data set, only three management types were considered: input controls (non transferable), individual transferable effort quotas and individual transferable quotas. The dummy variable relating to ITQs was excluded from the model to avoid the "dummy variable trap".

The CAPM model generally uses a standard stock market rate of return for comparison with the return on investment in the company, portfolio or sector in question. Initial analysis using the rates of return from the ASX All Ordinaries[3] to represent the market return resulted in a negative relationship between rates of return in fisheries and the market (Table 4). As we are not interested in the beta values *per se*, but how the risk premium is affected by the type of management in the fishery, an alternative comparator was sought. It could be argued that investing in the fishing industry is considerably different to investing in the stock market in terms of the risks faced, which (excluding management failure) are largely environmentally driven. A potentially more appropriate comparator is the return on investment in agriculture. Data on rates of return in Australian agriculture (all industries excluding dairy) were derived from the ABARE Agsurf survey database.[4] The rate of return in agriculture was closer to that of fisheries (Figure 2), with an apparent structural change occurring between 1999-00 and 2000-01.

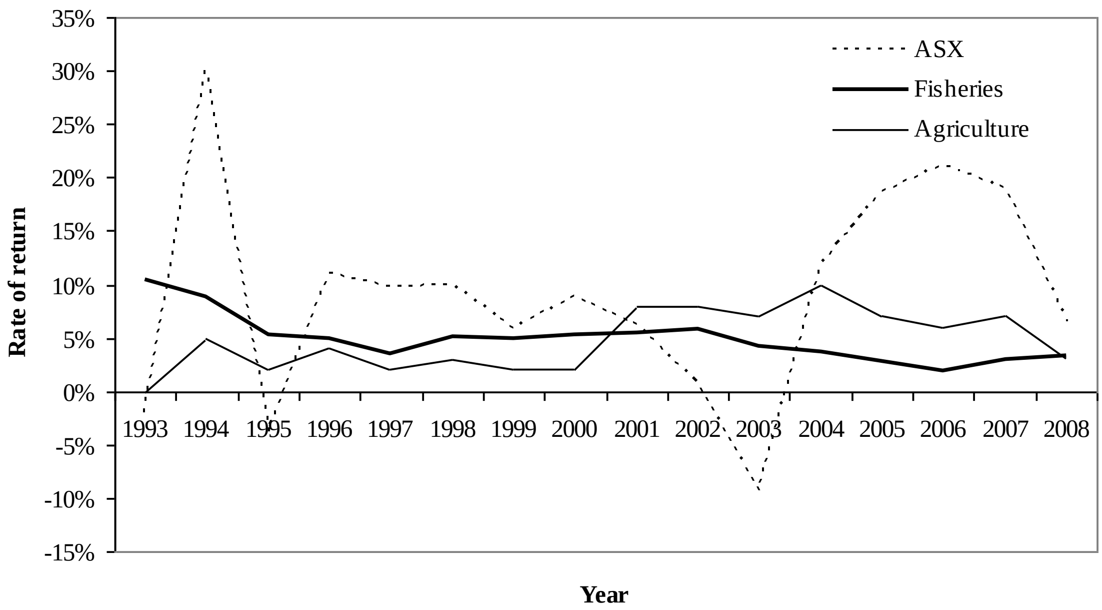

Figure 2. Comparison of average rates of return: Australian agriculture, fisheries and the ASX All Ordinaries, 1993-2008

The modified CAPM was estimated with the return to agriculture as the "market" indicator. A dummy variable representing the apparent structural change from 2000-01 was also included in the model as a shift parameter. The derived beta values represent the degree to which risk in fisheries diverges from that in agriculture rather than the traditional interpretation of beta in the CAPM model.

The model results for the CAPM and modified CAPM are given in Table 4. The model was estimated using a fixed effects formulation as there *a priori* evidence to suggest that the sample was not drawn

[3] Derived from Yahoo finance http://au.finance.yahoo.com/indices.
[4] http://www.abare.gov.au/interactive/agsurf/index.htm.

from a normal distribution. For example, one fishery under ITQ management (the offshore trawl sector) was characterised by persistent high rates of return. However, this fishery was effectively a mining operation based on orange roughy – a long lived species with a very low growth rate. Consequently, investment in the fishery needed to be recovered in a relatively short time period as the fishery was relatively short lived. Conversely, one South Australian fishery (the Scalefish fishery) had persistently negative rates of return. A random effects model was also estimated for comparison, and the specification tested using the Hausman test (Table 5). The results suggested that a random effects specification may be also appropriate. However, the fixed effects specification was retained for the reasons above.[5]

Table 4. CAPM model results – fixed effect specification

	CAPM			Modified CAPM					
Variable	Coef	Std. Error	t-Stat	Coef	Std. Error	t-Stat	Coef	Std. Error	t-Stat
Alpha	-0.020	0.009	-2.229	0.000	0.013	-0.028	0.003	0.010	0.319
Beta	-0.047	0.041	-1.132	0.300	0.212	1.411	0.236	0.195	1.208
Input controls	0.016	0.016	0.969	0.005	0.013	0.353			
ITE	0.008	0.029	0.269	0.009	0.022	0.427			
Input control slope	-0.026	0.067	-0.387	-0.186	0.216	-0.863			
ITE slope	-0.131	0.107	-1.223	-0.082	0.328	-0.251			
Structural shift				-0.026	0.014	-1.888	-0.028	0.014	-2.024
R-squared	0.601				0.602			0.599	
Adjusted R-squared	0.536				0.533			0.543	
Log likelihood	326.21				326.32			325.67	
F-statistic	9.191				8.764			10.698	
Prob(F-statistic)	0.000				0.000			0.000	
AIC	-3.685				-3.675			-3.717	

Table 5. Specification tests (modified CAPM)

	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random (Hausman)	5.722	6	0.455
LR test no management effects	1.113	4	0.892
LR test no ITQ effect (Table 6)	1.061	1	0.303

From Table 4, the two input based management systems both had positive intercept shift parameters, and negative slope parameters. *A priori,* it would have been expected that both would have had positive slope parameters as it would have been expected that the greater rights embodied in ITQs would have resulted in a lower β than the alternative systems. However, all of the parameters were individually not significant from zero, although the model overall was significant (based on the F-statistic). Removing the management related dummy variables had no significant impact on the model based on an LR test (Table 5). Further, the AIC value for the model without the management interventions was lower than that with the management dummy variables, suggesting the former model was more appropriate. This suggests that the type of management in place has no significant

[5] As the data came from two separate sources, differences in estimation approaches may account for some of the difference in rates of return. A dummy variable was included in initial analyses to examine the effect of data source, but this was not significant so was excluded in subsequent analyses.

impact on the implicit discount rate. The low β value also suggests that fisheries have a substantially lower risk premium than agriculture – contrary to expectations.

Given that the CAPM was derived based on the average market return representing a return on a well diversified investment, interpretation of the parameters in the previous modified model may differ to the usual interpretation. Agriculture is not necessarily representative of a diversified asset, so the beta values may not capture systematic risk only. As an alternative model, the risk premium associated with fisheries was examined directly by comparing the rates of return in the fisheries with the risk free interest rate (as in equation 3). A dummy variable representing ITQs only was introduced into the model as a slope shifter. From the results (Table 6), the parameter relating to ITQs was negative as expected, suggesting that ITQ based fisheries have a lower risk premium than non-ITQ fisheries. However, again, this parameter was not significant. Further, excluding the parameter had no significant impact on the model (LR test Table 5) suggesting that the management type has no significant impact on the risk premium.

Table 6. Rates of return compared to risk free interest rates – fixed effect specification

Variable	Coefficient	Std. Error	t-Statistic	Coefficient	Std. Error	t-Statistic
C	-0.009	0.033	-0.265	-0.020	0.032	-0.628
Interest	1.023	0.517	1.977	1.066	0.515	2.069
ITQ slope	-0.016	0.013	-1.297			
R-squared		0.599			0.597	
Adjusted R-squared		0.543			0.544	
Log likelihood		322.187			321.657	
F-statistic		10.696			11.216	
Prob(F-statistic)		0.000			0.000	
Akaike info criterion		-3.673			-3.679	

The results also suggest that the risk premium associated with fisheries is, on average, generally small. From Table 5, the slope associated with the risk free interest rate was not significantly greater than one, suggesting no risk premium.

5. Discussion

Using the CAPM approach to examine the risk perceptions in fisheries proved problematic, as the excess returns to capital (rate of return less the risk free interest rate) in fisheries was unrelated to the excess returns in the stock market – the traditional measure of a diversified investment. Newell et al (2005) assumed that the zero beta value in their study meant that there was little undiversifiable risk associated with holding fishing quota, and that the appropriate discount rate for the industry was close to the risk-free rate. From our study, the CAPM is most likely unsuitable for assessing risk perceptions in the fishing industry. Modifying the CAPM to use agricultural returns rather than the stock market as the benchmark may offer potential if the objective is to examine the relative effects of management on risk perceptions, but the values themselves may have no real interpretation. Returns to agriculture may include non-systemic risk, so the derived “beta” values will not necessarily reflect systemic risk perceptions.

The traditional CAPM has several other weaknesses. It is based on a restrictive set of assumptions relating to markets (including perfect information, no transaction costs, perfectly competitive capital markets) and investor behaviour (rational and risk adverse, able to borrow and lend at the risk free rate and hold well diversified portfolios therefore are only exposed to systematic risk). Whilst empirical tests of CAPM suggest a linear relationship between risk and return, results also indicate that there is something additional to systematic risk explaining return. That is, the intercept term generally does not equal zero. Empirical estimates of CAPM have also found that the actual slope of CAPM is less than predictive slope. That is high betas give slightly lower returns and low betas give slightly higher returns than predicted (Black 1993; Fama and French 1992). Finally, the ability to test the CAPM was argued to be impossible by Roll (1977) because of the market portfolio could not be identified and the stock market indices were a poor substitute (as the market portfolio should include all asses e.g. bonds, property etc). For reviews of the CAPM model

Alternative models have been developed to overcome some of the above issues. These include two factor models including Capital asset pricing model under uncertain inflation (CAPMUI) (Roll 1977; Friend 1976, Brueggeman et al 1984) and multi factor models such as Arbitrage pricing theory (APT) (Ross 1976) However these model are also not free of issues empirical estimation issues. For example, APT is a multi-factor model where expected risk premium on an asset depends on an asset's exposure to *n* macro economics factors that affect the assets returns (e.g. inflation, level of industrial activity, short and long interest rates and spread between yields of high and low corporate bonds (Brealey et al 2000) Other sources of risk may reflect characteristics specific to a firm's industry or sector. Risk is still only determined by factor risk, the underlying assumption of APT is still that unique risk is diversified away. Whilst, the APT does have greater intuitive appeal than CAPM, it is not without estimation difficulties, the key being identification of relevant factors.

The usual approach to estimating beta values is to estimate each firm or portfolio separately. Most studies use fine scale data – daily or weekly – with relatively large quantities of data. In the case of fisheries, data are only available at an annual level, and in most cases the series is discontinuous. Too few observations were available for any meaningful analysis using a standard approach, necessitating a pooling of data and panel data estimation techniques. However, this approach had additional advantages as it allowed the potential effects of different management systems on risk perceptions to be assessed directly in the model.

The use of rates of returns in fishing also is problematic. Most fisheries that have moved to ITQs have experienced increased levels of profit (Grafton 1996) as well as increased licence values (Copes 1986). Conversely, poor management may be expected to result in low levels of economic profit, so it would be expected that returns to capital in fisheries would be low that are not managed well. However, this would also be expected to be reflected in their licence values – a poorly managed fishery would be expected to have a low licence value relative to vessel capital. However, in all fisheries examined, licence values represented a substantial proportion of the total capital (Figure 3).

Both Hannesson (1996) and Asche (2001) noted that the move to ITQs was not immediately followed by a decline in the implicit discount rate, suggesting that increased experience with the system reduces uncertainty around the system. The models used in the analysis did not allow for changes in the discount rate over time, and for some of the ITQ fisheries, data were only available for a few years after the introduction of ITQs. The higher apparent rates of return observed in Figure 2 may reflect this lag in adjustment of implicit discount rates, resulting in lower license values than may occur in the longer term.

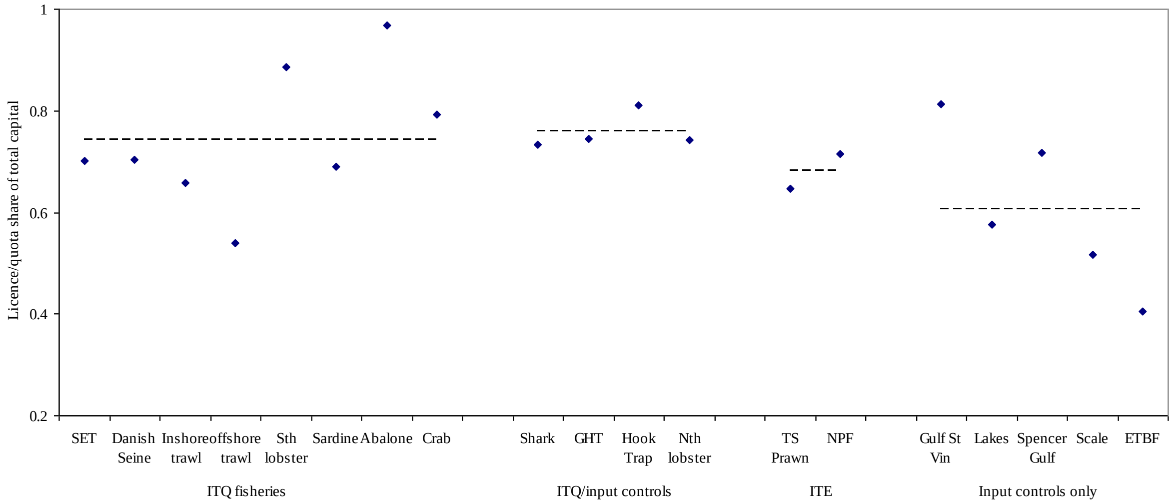

Figure 3. Licence/quota values as a share of total capital value (licence plus physical capital)

The potential for measurement error in the estimation of the licence/quota values also exists. For most of the non-ITQ fisheries, the number of licences traded each year was limited. Obtaining accurate values in such situations is complex, and errors in estimation will affect the resultant estimated rate of return. In ITQ fisheries, trading is more frequent, although the lack of a central market for quota makes determining the true quota price difficult. Most trades are undertaken between individuals for undisclosed amounts. Consequently, fishers' estimates of the total value of their quota holdings may be based on imperfect information.

Where ITQs have been introduced in Australian fisheries, generally not all species have been subject to quota controls at the same time. In the south east trawl fishery, for example, ITQs were introduced for a limited number of species only. Additional species have subsequently been brought into the quota system, but for much of the period of the data the fishery was characterised by a mix of ITQs and unrestricted catches. Further, the TAC of many of the ITQ species was not binding for most of the period of the data. Under such circumstances, the fishery retains many of the open access conditions and licence/quota values would not reflect the discounted future profits (Batstone and Sharp 2003).

Additional problems may also undermine fishers' confidence in an ITQ system. These include perceptions (real or otherwise) of cheating and illegal landings by other fishers as well as lack of confidence (or understanding) in the science underpinning TAC setting. A potential implication of the results is that changes in fisher behaviour may not be immediate by a move from open access to a property rights managed fishery. If perceptions of risk do not change for some time then investment behaviour is also unlikely to change. As a result, some of the key efficiency gains expected under an ITQ system may not be achieved, at least in the short to medium term.

6. Conclusions

The objective of this study was to determine if the implicit discount rate – reflecting perceptions of risk in fisheries – was affected by the type of management system in place. An *a priori* expectation was that rights based fisheries would have lower implicit discount rates as fishers had greater certainty about future catches, and expectations about higher future profits due to the removal of the race to fish. From the available data, such a relationship could not be established. This does not mean that such a relationship does not exist – just that it is not apparent in the available data. From the work of others (e.g. Asche 2001), changes in risk perceptions may take time to develop under an ITQ program. Consequently, fisher behavioural changes may not be immediate, and the potential efficiency gains from an ITQ program may not be realised for some time after their introduction, even if all other aspects of the system are correctly in place (i.e. optimal TACs, efficient quota market).

The study also attempted to apply standard financial models to examine risk perceptions in fisheries and identified several problems with such approaches. While some of these relate to the data themselves, it is also apparent that such tools are not directly relevant to industries such as fisheries.

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