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Quantifying Time-varying Term-risk Premia in Shipping Markets

A Possible Approach

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I am grateful for the comments and suggestions of an anonymous referee. I am responsible for any remaining errors.

Abstract

Recent empirical work, as part of its attempt to establish the expectations hypothesis and explain the term structure of shipping freight rates, has identified the presence of time-varying term-risk premia in shipping markets. Consequently, to proceed further in any such research, a way must be found to model this variable independently from the expectations hypothesis. This paper considers one possible approach that involves deriving a relationship between market risk and market discount rates. This relationship is then employed to illustrate how term-risk premia in shipping markets might be quantified.

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1.0 Introduction

In retrospect, what must perhaps be considered most surprising about the identification of time-varying term-risk premia in shipping markets by Kavussanos and Alizadeh-M (2002) is that, prior to their paper, when specifying the expectations hypothesis, the term-risk premium had in fact been considered properly modelled as a constant rather than as a variable. After all, as term-risk premia represent the market valuation of the increased uncertainty that accompanies trading on the spot market as opposed to fixing on the time charter market, it is surely to be expected that, in a sector in which markets are primarily dependent on the, inevitably, cyclical level of global economic activity, expectations regarding the certainty of future revenues or costs will vary from period to period. Nevertheless, this, albeit recent, change in perspective on the nature of term-risk premia does have significant implications for any future attempt to explain the term structure of freight rates in the shipping market using the expectations hypothesis. Now, any test of the expectations hypothesis will not only require time series data on freight rates but also time series data on term-risk premia. As it is difficult to conjecture where data on the latter may be obtained, it may well be that we have reached an impasse in this particular area of maritime economics research. An initial study by Adland and Cullinane (2005) surveyed the area but was restricted to speculation on the likely sign of the term-risk premium. A different starting point would be to adopt an interview approach, questioning market traders about their perceptions of term risk and their responses to it, in the hope that these responses would prove to be a stable function of a number of objectively quantifiable variables. Any such study would, however, have to seriously consider the likely accuracy of such verbal responses as it seems debatable that market traders would wish accurately to divulge such price-sensitive information. Clearly, to make further progress in testing the expectations hypothesis, it is necessary to quantify term-risk premia but, before this can be considered, an approach that is capable of such a task must be developed.

Of course, were the expectations hypothesis already established, term-risk premia could simply be modelled as the spread between, for any specific period, the present value of time charter earnings and the present value of expected spot charter earnings. However, as tests of this hypothesis have, to date, been unsuccessful (for example, Hale and Vanags, 1989; Veenstra, 1999; Kavussanos and Alizadeh-M, 2002), such an approach is not an option. Indeed, this suggestion illustrates the circular aspect of the problem. We cannot, apparently, observe time-varying term-risk premia without first establishing the expectations hypothesis and we cannot establish the expectations hypothesis without first observing the relevant time-varying term-risk premia. This paper proposes to try to resolve this stalemate by deducing a relationship between term risk and observable market data. Specifically, the paper aims to produce a model that bases the estimation of term-risk premia in shipping markets on the current yield of financial assets as well as on the expected variability of future earnings in spot markets. Shipping, as one possible home for capital funds, has, necessarily, to compete with all other sectors, with the result that expected financial returns to shipping will not be isolated from wider market movements and an approach that recognises this fact has clear advantages.

This paper has the following structure. The conventional methodology for testing the expectations hypothesis of the term structure of freight rates is outlined. The paper then reformulates the hypothesis so that, instead of including a term-risk premium to allow for term risk, a risk-adjusted discount rate is employed and this model is manipulated to illustrate how the term-risk premium might then be quantified. In order to establish a relationship between market risk and market discount rates, the paper considers the Modigliani–Miller Cost of Capital Thesis in which such a relationship is established. By making a number of further assumptions, this relationship allows the quantification of the term-risk premium as a function of both current yields on market assets and the variability of expected future earnings on the spot market. The paper concludes by illustrating how the model would be used in practice.

2.0 Theoretical Review

The expectations hypothesis of the term structure in shipping markets, as conventionally expressed, holds that the present value of earnings from a time charter will be equal to the present value of expected future spot charter earnings for the same period plus a term-risk premium so that, for example,

$$PV_t^{\mathrm{TC}} = PV_t^{\mathrm{SC}} + \phi_t = \sum_{i=1}^{i=n} (1+\delta_t)^{-(i/12)} E_t S_{t+i} + \phi_t, \tag{1}$$

where PV_t^{TC} is the present value in period t of earnings from the time charter, PV_t^{SC} is the present value in period t of the expected earnings from n future one-month spot charters for the same period, δ_t is the (unadjusted for term risk) discount rate in period t, $E_t S_{t+i}$ is the expected value in period t of the spot rate in period $t+i$ and ϕ_t is the time-varying term-risk premium.

An alternative to this conventional approach, which we will adopt, is to re-specify PV_t^{SC} using a discount rate, τ_t, that has been adjusted to allow for the perceived term risk that would accompany the decision to take a series of spot charters rather than a period charter. This adjustment would eliminate the need for ϕ_t, the time-varying term-risk premium, and would more closely correspond to how companies are generally perceived as reacting in practice to market risk, which is to alter their discount rates accordingly (Samuels *et al.*, 1992) so that

$$\sum_{i=1}^{i=n} (1 + \delta_t)^{-(i/12)} E_t S_{t+i} + \phi_t = \sum_{i=1}^{i=n} (1 + \tau_t)^{-(i/12)} E_t S_{t+i}, \tag{2}$$

which would mean that

$$\phi_t = \sum_{i=1}^{i=n} (1 + \tau_t)^{-(i/12)} E_t S_{t+i} - \sum_{i=1}^{i=n} (1 + \delta_t)^{-(i/12)} E_t S_{t+i}, \tag{3}$$

and where we would expect $\phi_t < 0$, reflecting the likelihood of preferred habitats on the demand side and a willingness of ship owners to offer discounts on the supply side to secure time charters and thereby reduce the risks attached to their future earnings (Wright, 2007).[1] This specification for ϕ_t makes no reference to period rates and would therefore provide estimates that are independent of the expectations hypothesis.

Clearly, to operationalise this model we need data on both expected future spot earnings and our discount rates, δ_t and τ_t. By assuming rational expectations so that

$$E_t S_{t+i} = S_{t+i} + v_t, \tag{4}$$

where $E_t S_{t+i}$ is the expected value in period t of the spot rate in period $t + i$, S_{t+i} is the spot rate in period $t + i$ and v_t is the orthogonal forecast error, we can quantify expected future spot rate earnings leaving as our remaining problem the question of our discount rates. To introduce a possible solution to this problem, we must briefly digress and consider some aspects of asset valuation theory contained in the Modigliani–Miller Cost of Capital Thesis.

[1]The concept of a preferred habitat (Modigliani and Sutch, 1966) refers to the possibility that, on either the demand or the supply side, agents may naturally prefer to trade either short or long. For example, in shipping markets a company looking to transport a regular and vital consignment of a raw material to their processing plant will have a natural tendency, a preferred habitat, to fix long so as to be able to guarantee supply, whereas another company that perhaps has to make one specific adjustment to its inventory, in so doing redistributing product to an outlet abroad, may naturally wish to charter short to cover this one particular event.

Among other things, the Modigliani–Miller Cost of Capital Thesis asserts that, under specific institutional conditions, two firms cannot have different market values simply because they have different financial structures. Indeed, the thesis asserts that the value of the firm will depend upon the net present value of its future earnings, regardless of the relative proportions of equity and debt that have been used to finance the purchase of the firm's assets. Modigliani and Miller (1958) demonstrated that, were this not to be the case, opportunities would exist for corporate arbitrageurs so that market forces would operate to ensure that this constraint was binding. This conclusion can also be expressed as asserting that the average cost of capital to the firm is constant with respect to financial risk in the form of alterations to the level of leverage or gearing (the ratio of debt to equity in the firm's financial structure) so that

$$K_{\mathrm{O}} = K_{\mathrm{E}}\left(\frac{E}{E+D}\right) + K_{\mathrm{D}}\left(\frac{D}{E+D}\right), \tag{5}$$

where K_{O} is the weighted average cost of capital, K_{E} is the expected return to equity (E) and K_{D} is the expected return to debt (D). As, from the perspective of the equity shareholders in a firm, increased leverage or gearing implies a greater variability in expected earnings, or greater risk, it is possible, using this imposed relationship, to infer how risk and equity discount rates might be related. Further, if we can assume that the market would, for consistency, generally impose this relationship, it can also be employed when valuing business opportunities, such as the choice between a time charter or a series of spot charters. Were this not to be the case, as is argued in the Modigliani–Miller Cost of Capital Thesis, significant arbitrage opportunities would arise and the market would impose a correction. Given, then, that it proves possible to model this relationship between risk and equity discount rates, it should be possible, assuming we can also model the term risk associated with the variability of expected future equity earnings on the spot market, to evaluate (3) and thereby quantify time-varying term-risk premia in shipping markets.

3.0 The Model

In the approach outlined above, in order to quantify term-risk premia in shipping markets, we must establish two relationships, a relationship between risk and equity discount rates and a relationship between risk and the variability of expected future earnings to equity on spot markets. To proceed with this task, we need to make a number of assumptions:

- that, for any given expected earnings profile, the risk to equity in a company financed entirely by equity is, approximately, equivalent to the risk to debt in a company financed almost entirely by debt;[2]
- that from the perspective of the financiers of the company, the earnings profile associated with a shipping company can be represented by a set of earnings figures, with their associated probabilities, that represents both normal trading conditions and unwelcome trading conditions;
- that the risk associated with any option for ship owners can be measured by the dispersion of the values of the outcomes associated with it;[3]
- that the market is consistent in the specification it employs to relate risk and equity discount rates;
- that the expected dispersion of future spot rates is equal to their actual dispersion.

To develop our approach, we now consider a simple model in which we have two shipping companies, Company A and Company B, both of which, initially, have fixed their tonnage on one-year time charters and which, consequently, do not need to consider term risk. The two companies are identical except that Company A is financed entirely by equity and Company B is financed almost entirely by debt. In such a case, we would expect that the expected yield to equity in the first company (K_E^A) is, approximately, equal to the expected yield on debt in the second company as the risks faced by both, in terms of their expected earnings profile are, approximately, the same. Grammenos and Arkoulis (2003) have investigated the determinants of yields on shipping company debt and have found that, on average, debt requires a 4.281 per cent premium on an equivalent government security with a 0.255 per cent additional premium for each unit of gearing.[4] If, then, we allow for an additional nineteen gearing units to model the expected yield on debt in our second company, we produce the following relationship for the expected yield to equity in the first company

$$K_E^A = K_G + 9.126, \tag{6}$$

[2]Obviously, a company must have some equity finance.
[3]Where dispersion is defined as the standard deviation of the associated distribution.
[4]Gearing defined here as the ratio of debt to equity.

where K_G is the yield on the government security.[5] However, as K_E^A, the expected yield to equity in Company A, will also represent δ, our (unadjusted for term risk) discount rate, we also have

$$\delta = K_G + 9.126. \tag{7}$$

We now assume that the expected earnings profile for Company A for the year can be represented by a series of monthly figures that represent the expected earning outcomes as they would accrue to the equity shareholders. This profile, as we have previously assumed, will reflect estimates of trading outcomes under both normal and unwelcome trading conditions. Under this second heading, we would include, for example, the possibility of an equipment failure of some kind or the possibility of the complete cessation of the contract due to a serious mishap, perhaps because of the business failure of some party to the trade agreement that had given rise to the charter.[6] As our shipping company is trading on the period market rather than the spot market, our monthly equity earnings figures for normal trading outcomes will be equal and we would expect these outcomes to dominate the expected earnings profile. Indeed, we will model this scenario as one in which normal trading is expected in eleven months and in the twelfth month for there to be the expectation that equity earnings would only be half the normal figure, reflecting the possibility of a disruption of some kind to the charter agreement. The expected value of this series is then approximately equal to 96 per cent of the mid-period return expected were normal trading conditions to pertain for all twelve months.

We can now calibrate our expected equity earnings profile on x, the expected, per month, one year time charter equity dollar earnings during normal trading conditions, as we would anticipate that its expected annual value, exp(R), is such that it produces the expected annual yield K_E^A.[7] We can expect then that[8]

$$K_E^A = \frac{\exp(R)}{E} = \frac{11.5x}{E}, \tag{8}$$

[5]The specific allowance that should be made for additional gearing is, unfortunately, a complex matter. First, we cannot be sure what constitutes an average level of gearing in the shipping sector. Second, given that gearing, in this context, is defined as D/E, there is, effectively, no upper limit we can work to. Third, as was remarked above in footnote 2, a company must have some equity finance. Our assumption of an additional nineteen gearing units covers, for example, a range from 0, where the company is completely financed by equity to a value of 19, where the company is financed by 95 per cent debt and 5 per cent equity, so that, to quantify K_E^A, we must add to K_G nineteen times 0.255 per cent as well as the average debt premium of 4.281 per cent.

[6]We also include in this second figure the possibility that the shipping company itself may cease trading.

[7]We will work in dollars as freight rates are quoted in this currency.

[8]In practice, we would, of course, expect equity values to adjust so that the expected yield is achieved, whatever the earnings profile.

or

$$x = 0.087 K_{\mathrm{E}}^{\mathrm{A}} E, \tag{9}$$

and, if we standardise on a value of E of \$100, then

$$z = 8.7 K_{\mathrm{E}}^{\mathrm{A}}, \tag{10}$$

where z is the expected, per month, one-year time charter equity earnings during normal trading conditions per \$100 of equity.[9]

We will now use our model to investigate the relationship between expected market discount rates and the dispersion of expected equity earnings. Specifically, by increasing the proportion of debt in our company we can observe the change in the dispersion of expected earnings to equity. This change in dispersion reflects the fact that increases in the proportion of debt in the financial structure of a company will alter the profile of expected returns to equity. We can calculate the increase in dispersion of the earnings profile, as measured by the standard deviation (σ), and use (5) above also to calculate the value of $K_{\mathrm{E}}^{\mathrm{A}}$ that the market requires to compensate for the additional financial risk. By systematically repeating this procedure with increasing proportions of debt, we will generate observations on $K_{\mathrm{E}}^{\mathrm{A}}$ and σ from which we can derive a relationship between market risk and market discount rates.

Once we have established this relationship, we can extend the model to cover term risk. We now assume that our second company, Company B, decides, first, to refinance, so that like Company A, it is also financed entirely by equity, and, second, that it decides to switch to trading on the spot market. As a result, Company B will now face term risk with the same capital structure as Company A. This trading switch will be reflected in a greater dispersion of expected earnings to equity in Company B. As a result, $K_{\mathrm{E}}^{\mathrm{B}}$, the expected return to equity in Company B, which also represents τ, our (adjusted for term risk) discount rate, will, necessarily, be greater than $K_{\mathrm{E}}^{\mathrm{A}}$, which represents δ, our (unadjusted for term risk) discount rate. As such, the difference in the expected returns to equity in Company A and Company B will represent the discount rate spread that is required to allow for term risk. To quantify τ, we must first measure the dispersion of the expected earnings to equity profile for one year of trading on the spot market. Once this has been achieved, we can then use our derived relationship between market risk and market discount rates

[9] As will be required later, for any particular market equilibrium, we can also calculate the ratio of z to the market one-year time charter rate and use this ratio to adjust spot rates to produce approximately equivalent time series.

to estimate its value. Clearly, the expected earnings profile of a company operating on the spot market, as opposed to the period market, must reflect both the uncertainty about future market rates under normal trading conditions and the greater risk that abnormal and unwelcome trading conditions pertain. We will attempt to reflect the first of these concerns by assuming that the expected variability of expected future rates is equal to the actual variability and, hence, that the expected range is equal to the actual range. With respect to abnormal trading conditions, we will again assume that they pertain in one of our twelve months but that in this month there is an expected loss attached to abnormal trading on the spot market which is equal, in absolute terms, to one quarter of the average normal trading return to equity from tonnage fixed on the period market. This assumption reflects the fact that we would expect a greatly increased probability of abnormal and unwelcome trading conditions, and their associated losses, in spot trading. For example, a company operating on the spot market would, in general, expect, in addition to all the various risks experienced in the period market, a considerable risk of their tonnage being, at some point, unemployed during the year. Additionally, there are the risks attached to spot trading from the prospect of a falling market which would significantly increase the general probability that the company would have to cease trading. Finally, once we have established our values for δ and τ, we can substitute in (3) and quantify the term-risk premium.

4.0 An Illustration of the Model

Let us assume, for example, that we wish to estimate the term-risk premium for a one-year time charter. If we assume that K_G is 6.252 per cent, then $K_D = 10.533$ per cent, and from (7) and (10) above, we find that $\delta = 15.378$ per cent and $z = \$1.34$. We can now investigate the effects of increasing financial risk on K_E and σ. If we systematically increase gearing, we can calculate the values for σ, the dispersion of the returns to equity for our assumed earnings stream, which will become greater as the proportion of debt finance increases.[10] The results are detailed in Table 1.

[10] If we restrict the range of debt increases to less than one unit of gearing, it seems reasonable to assume that we can avoid having to recalculate the expected return to debt due to increases in the level of financial risk experienced by bond-holders.

Table 1
Financial Structure, Equity Earnings, Returns to Equity, Dispersion and Required Equity Yield

Financial structure			Equity earnings ($ per month)		Returns to equity (% per month)		Dispersion	Required equity yield (%)
E	*D*	*D/E*	*Months 1–11*	*Month 12*	*Months 1–11*	*Month 12*	σ	K_E
100	0	0.00	1.34	0.67	1.34	0.67	0.00193	15.378
98	2	0.02	1.32	0.65	1.35	0.66	0.00197	15.477
96	4	0.04	1.30	0.63	1.36	0.66	0.00201	15.580
94	6	0.06	1.29	0.62	1.37	0.66	0.00206	15.687
92	8	0.09	1.27	0.60	1.38	0.65	0.00210	15.799
90	10	0.11	1.25	0.58	1.39	0.65	0.00215	15.916
88	12	0.14	1.23	0.56	1.40	0.64	0.00220	16.039
86	14	0.16	1.22	0.55	1.41	0.63	0.00225	16.167
84	16	0.19	1.20	0.53	1.43	0.63	0.00230	16.301
82	18	0.22	1.18	0.51	1.44	0.62	0.00236	16.442
80	20	0.25	1.16	0.49	1.45	0.62	0.00242	16.589
78	22	0.28	1.14	0.48	1.47	0.61	0.00248	16.745
76	24	0.32	1.13	0.46	1.48	0.60	0.00254	16.908
74	26	0.35	1.11	0.44	1.50	0.60	0.00261	17.080
72	28	0.39	1.09	0.42	1.52	0.59	0.00269	17.262
70	30	0.43	1.07	0.41	1.54	0.58	0.00276	17.454
68	32	0.47	1.06	0.39	1.55	0.57	0.00284	17.658
66	34	0.52	1.04	0.37	1.57	0.56	0.00293	17.874
64	36	0.56	1.02	0.35	1.60	0.55	0.00302	18.103
62	38	0.61	1.00	0.34	1.62	0.54	0.00312	18.348
60	40	0.67	0.99	0.32	1.64	0.53	0.00322	18.608

In Table 1 we have tabulated K_E and σ. On investigation, we find the following linear and exact relationship

$$\frac{(K_E - K_D)}{\sigma} = 25.05. \tag{11}$$

However, as K_E, the expected yield to equity, will also represent τ, our (adjusted for term risk) discount rate, we also have

$$\tau = 25.05\sigma + K_D. \tag{12}$$

We can now investigate the value for σ that would result from taking a series of spot charters. Let us assume that the observed one-year time charter rate in a particular period was 28 ($000 per day) and spot rates (time charter equivalent ($000 per day)) for the twelve months were 29, 31, 32, 33, 38, 34, 34, 34, 32, 31, 33, 36. Using the earnings profile described above, we find that the distribution implied has a standard deviation of 0.005602, indicating a value for τ of 24.56 per cent. Finally, if we substitute our values for δ, τ, and our spot rates into (3), we find an absolute value for ϕ of, approximately, 3.5 per cent of the present value of expected earnings from operating on the spot market for one year.

5.0 Conclusions

This paper aimed to explore a possible approach to quantifying term-risk premia in shipping markets that focused on the links between risk and discount rates that are apparent in capital markets and investment appraisal theory. Specifically, the association required by the Modigliani–Miller Cost of Capital Thesis between financial risk and expected equity market rates of return was used to derive a relationship between the dispersion of expected equity earnings and equity discount rates. By making a number of assumptions about the nature of the risk profile facing equity in shipping contracts fixed on either the period or the spot market, it was possible, as an illustration of how the model would work, to use this relationship to quantify the term-risk premium for the example of a one-year time charter. Of these assumptions, perhaps the most contentious are likely to be those that allowed the earnings profiles used to be constructed. Although it is relatively easy to list the various elements that such a profile might contain, it is far less easy to attribute probabilities and values to the various outcomes and, in particular, to those that represent the risks attached to trading on the spot market. It may well be that the choices made in this paper attract comment and criticism, but this is considered part of the appeal of adopting such a modelling approach in that it explicitly requires such issues to be opened up to debate. The model itself has a number of attractive features.

1. It appears relatively easy to operationalise.
2. By using risk-adjusted discount rates to allow for term risk, it moves the expectations hypothesis closer to accepted financial theory on market behaviour in the presence of risk.
3. The results produced by our illustration of the model were encouraging in that they indicated what might be considered a plausible estimate for a term premium associated with the one year time charter market. Given that we would expect term risks to increase with the length of the period charter, we would expect this premium to increase also as longer time charters are considered. This would be reflected in the model by an increased dispersion of expected earnings and in an increased estimate for τ, our (adjusted for term risk) discount rate.

4. The model explicitly links term premia to rates in capital markets, through (3) above.
5. The model can be easily adjusted to allow for any perceived changes in the risks associated with supplying tonnage to spot markets through adjustments to the expected earnings profile. Clearly, if it was felt appropriate, it would be quite possible to use this approach to generate estimates of term-risk premia for any particular period charter, given the availability of the appropriate time series data. This, in turn, would produce data that could be used to test the expectations hypothesis and, hopefully, explain the term structure of shipping freight rates. As, on balance, it would seem that the approach has something to offer, it is hoped that this might indeed be the next stage for this research.

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