Chapter 9
Valuing Vessels

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Abstract For a long time, the valuation of vessels was a routine task based simply on the price of comparable vessels in recent transactions. However, since the beginning of the global financial and economic crisis in 2008, with vessel prices, if any observable, at record lows and market volatility at record highs, there has been a controversial discussion on whether the transaction price always represents the vessel's true value. As a result, valuation approaches based on earnings estimates are gaining increasing acceptance. A popular example of such an approach in the maritime industry is the Long Term Asset Value (LTAV) method. The LTAV method is based on a discounted cash flow (DCF) analysis, which is already commonly used and widely accepted for the valuation of businesses and long-lived assets. This chapter presents the basic principles of vessel valuations and places a special focus on the LTAV method. Particular attention is placed on the determination of reasonable valuation parameters as well as on the application possibilities of the LTAV method.

9.1 Introduction

For a long time, the valuation of vessels was a routine task. A vessel's value was derived simply from the price of a comparable vessel in a recent transaction (so-called market approach). However, since the beginning of the global financial and economic crisis in 2008, with vessel prices, if any observable, at record lows and market volatility at record highs, there has been a controversial discussion on whether the in the best case few observable transaction prices always represents the vessel's intrinsic value. To determine the value of a vessel in an environment of high volatility and uncertainty, valuation approaches based on earnings estimates are gaining increasing acceptance. A main advantage of these valuation approaches is

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that they are based on a long-term view, which is supposed to offset short-term market imperfections at least to a certain degree. A popular example of such an approach in the maritime industry is the Long Term Asset Value (LTAV) method, which was developed in 2009 by the Hamburg Shipbrokers' Association (*Vereinigung Hamburger Schiffsmakler und Schiffsagenten e.V., VHSS*) in cooperation with the accounting and consulting firm PricewaterhouseCoopers (PwC). The LTAV method is based on a discounted cash flow (DCF) analysis, which is already commonly used and widely accepted for the valuation of businesses and many long-lived assets (e.g. real estate, aircrafts, and power plants).

This chapter presents the basic principles of vessel valuations and places a special focus on the LTAV method. First, the most common reasons for vessel valuations, as well as the main different valuation approaches, are discussed. This is followed up with a discussion on the appropriateness of the market approach in the current market environment. Next, the main part of this chapter places particular attention to the LTAV method and its input parameters. Finally, typical, practical instances for using the LTAV method are described.

9.2 Reasons for Valuations and Valuation Approaches

9.2.1 Reasons for Valuations

There are several reasons why valuations of vessels are required. Vessel owners need vessel valuations for accounting (e.g. impairment test), planning (e.g. as a basis to decide on a potential capital increase) and controlling purposes. Potential buyers and sellers of vessels base their investment or divestment decisions on valuations. Shipbrokers use valuations when advising their clients in the course of transactions. Vessel valuations are also crucial for banks. Valuations determine lending decisions, borrower compliance with existing loan covenants, bank compliance with capital adequacy standards, and provisions for credit losses.

The demand for valuations rises especially in tough market conditions. As such, for example, the current shipping crisis has led to a consolidation within the market, which has resulted in an increased demand for valuations triggered by company law (e.g. valuations regarding ownership changes).

9.2.2 Valuation Approaches

Generally, the value of a vessel is based on the future financial benefits which both equity and debt investors can expect to receive as of the valuation date. The three widely accepted valuation approaches are the market approach, the income approach, and the cost approach. When markets are stable and market participants' assessment of future events are similar (low market volatility), all three valuation approaches usually provide comparable results for typical vessels. In contrast, if the course of future events seems to be highly uncertain, these approaches can provide a broad range of values and can be utilized as complementary methods for assessing the value from different points of view (e.g. going concern vs. liquidation scenario).

- **Market approach**
  According to the market approach (also known as the "last done", "mark-to-market", or "comparative valuation" approach), a vessel's value equals the market price of comparable vessels in recently completed arm's-length transactions between willing and knowledgeable buyers and sellers. To value a vessel using the market approach, a set of the most recently completed transactions of comparable vessels and the appertaining transaction prices must be identifiable. Comparability is based on four main factors: vessel type, size, age, and condition.[1] Additionally, immediacy is also a key issue: the need to sell quickly ("fire sale") normally results in a much lower price.
- **Income approach**
  Under the income approach, the value of the vessel is the present value of all future cash flows the vessel is expected to generate during the remaining economic useful life including its residual scrap value at maturity. While the income approach is the most theoretically rigorous approach available and is widely accepted as a proper approach for determining the value of assets including vessels, determining appropriate input parameters—particularly forecasts of charter rates—can be considered the most critical task. As the income approach requires a financial model with cash flow projections, it is also known as the mark-to-model approach.
- **(Replacement) Cost approach**
  According to the replacement cost approach, the vessel is valued based on how much it would cost to build a similar vessel in the same condition. The replacement cost of the vessel is adjusted for depreciation caused by physical deterioration and functional obsolescence. The replacement cost approach is mostly applicable to vessels with unique functionality or customized features (special vessels). Examples are maintenance, research, and floating museum vessels. The most obvious critique of this valuation method is that it does not consider the future cash-generating ability of the asset.

9.3 Equivalence of Value and Price

In fact, by far most people in the shipping business use some version of the market approach to value vessels. The central assumption underlying this approach is that the observable market prices reflect the fundamental or intrinsic value of

[1] Fixed charter agreements and other factors also affect prices. These include but are not limited to fuel consumption, classifications, type of the main engine, loading equipment (cranes and derricks), the shipyard where the vessel was built, and the location of the vessel at the time of sale.

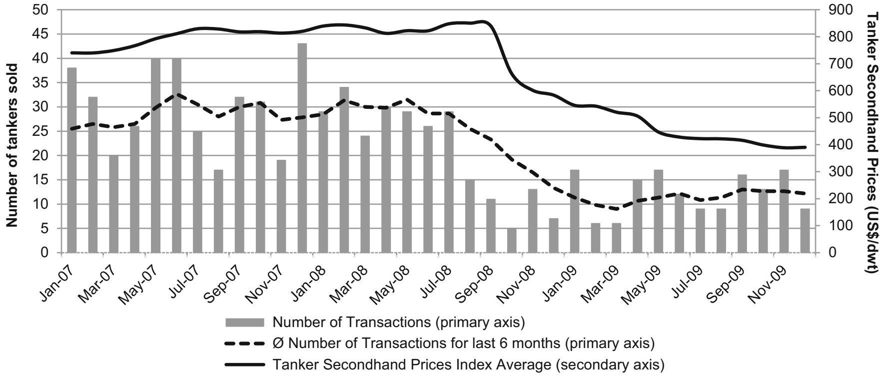

Fig. 9.1 Secondhand Prices and number of transactions for Tankers between January 2007 and December 2009. *Source*: Clarkson Research Services

the vessel. To use this as a reasonable assumption, various main conditions of the equivalence of value and price must be satisfied. There must be a sufficient number of recently completed arm's-length transactions with comparable vessels between willing and knowledgeable parties. The transactions must not include distressed or forced sales due to liquidity problems of vessel owners ("fire sale"), and credit must have been sufficiently and readily available to market participants. In addition, market participants should face low research and transaction costs within the transaction process. Finally, market participants should not be characterized by excessive optimism or pessimism (prudent investors).

An analysis of these prerequisites in light of the actual market conditions leads to the following results:

In consequence of the global financial and economic crisis, the number of accomplished vessel transactions decreased substantially. Moreover, these few vessel transactions are characterized to a large part by forced sales of ship owners with liquidity problems which resulted in a steep decline in the market prices (see Fig. 9.1).

In addition, loans granted by banks decreased substantially because of the financial crisis (see Fig. 9.2). Nowadays, to obtain a bank loan, additional collateral apart from the underlying vessel to be financed must often be provided. As vessels are financed largely than other assets with debt, particularly the shipping industry has suffered from the limited availability of bank loans.

The shipping market is also characterized by both excessive optimism and pessimism on the part of the market participants. This is expressed in the volatility of the vessel prices, freight rates, and the development of stock prices of shipping companies compared to the development of the economy and the stock market in general (see Fig. 9.3).

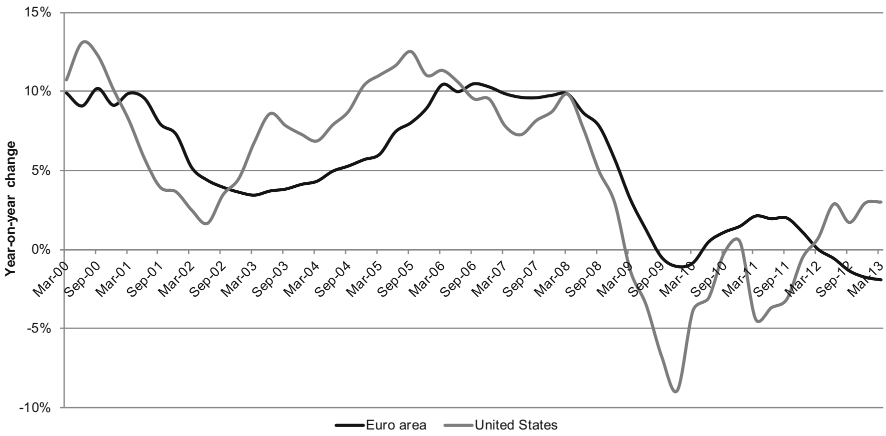

Fig. 9.2 Bank credit to the private non-financial sector. *Source*: Bank for International Settlements

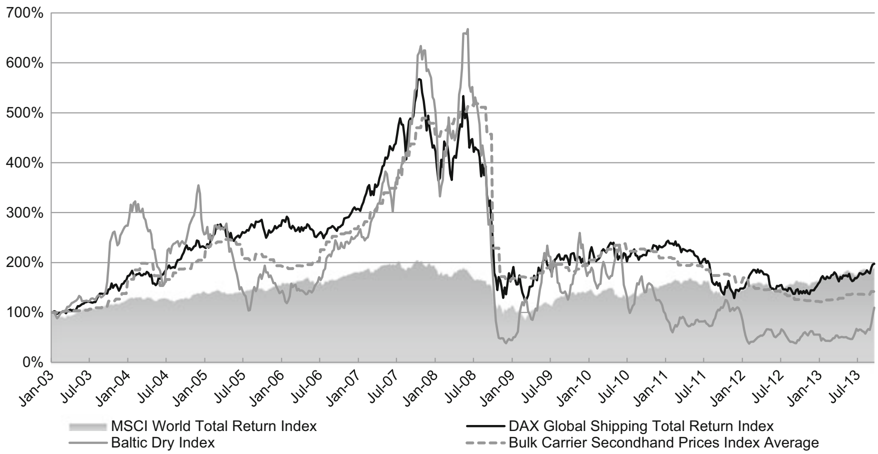

Fig. 9.3 Historical development of certain indices (indexed 1 January 2003). *Source*: Bloomberg, S&P Capital IQ, Clarkson Research Services

One reason for this high degree of volatility and the exaggerated market phases in the shipping markets is a delayed adjustment of the market supply to changes in the market demand, so-called pork cycles,[2] which intensifies the general price

[2]The pork cycle phenomenon for the shipping markets can be described as follows. In boom phases in the economy resulting from a strong demand in the market, high charter rates, as well as high secondhand prices, can be realized for vessels. Owing to the high profits which can be obtained, an increase in investments in new vessels occurs leading to an increased supply only with a delay due to the time for construction. As a result, there is normally an excess supply, especially if the market demand has decreased in the meanwhile. The consequences of this excess supply are substantially

fluctuations. Another reason is of structural nature: In the last market upswing attracted by tax advantages, favorable financing conditions (low credit margins) and prospects of high profits on the second-hand market the market participants showed excessive optimism with the result that more vessels than necessary were ordered with respect to the effective long-term market demand. Contrary to this, the market participants in the current shipping market trough are expressing excessive pessimism, leading to comparatively few loans and investments, despite expected strong future market demand. While the excessive optimism intensified the last market upswing, the resulting strong fleet growth in combination with the economic downturn in 2008/2009 have led to an excessive pessimism on the part of the market participants and a massive collapse of the market. However, both the scope of the upswing and the extent of the downswing do not reflect the realistic long-term market perspective.

Because of the shipping market environment market prices of comparable vessels are often distorted and the common market approach provides no reliable valuation results assuming a long-term going concern scenario. Instead, especially in phases of market disruption, valuation methods that are based on the long-term earnings potential of a vessel (income approach) are needed. This issue can be addressed by using the LTAV method; the general principles of this method are recorded in the Hamburg Ship Evaluation Standard (HSES).

9.4 The LTAV Method

9.4.1 Methodology

Considering only financial objectives, the value of a vessel is determined from the vessel's ability to generate financial surpluses for the suppliers of capital, both equity and debt. The determination of the LTAV, according to the HSES, is based on the DCF method and the concept of weighted average cost of capital (the so-called WACC approach[3]), which is widely recognized in theory and the valuation practice.

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lower charter rates and a downturn in prices for vessels which lead to an investment backlog that affects the supply again with some delay. Additional scrapping of vessels increases the reduction in capacity and leads to a shortfall in supply during the next economic recovery. The described cycle then begins anew.

[3]In addition to the WACC method, there are two other recognized DCF methods for determining the asset value, the adjusted present value (APV) method, and the total cash flow (TCF) method. These differ especially in the definition of the underlying cash flows, how the tax benefits from debt are taken into account as well as in the underlying discount rate. All DCF methods lead to identical results in the case of consistent premises. Depending on the purpose of the valuation, the determination of the value of a stake in a single-vessel company exclusively from the point of view of the suppliers of equity capital can be relevant, instead of the valuation of the vessel as an asset from the point of view of the suppliers of equity and debt. In this case, the market value of debt

The LTAV of a vessel is derived accordingly by discounting the expected free cash flows (FCF_t) with the weighted average cost of capital (WACC):

$$\text{LTAV} = \sum_{t=1}^{T} \frac{\text{FCF}_t}{(1+\text{WACC})^t} = \sum_{t=1}^{T} \frac{(C_t - \text{OPEX}_t)}{(1+\text{WACC})^t} + \frac{\text{RV}_T}{(1+\text{WACC})^T} \tag{9.1}$$

The free cash flows can be derived using the forecast charter revenues (C_t) less the expected costs for operating the vessel ($OPEX_t$), as well as a residual value (RV_T) at the end of the vessel's economic useful life.

9.4.2 Determination of Free Cash Flows

- **Charter revenues** (C_t)
  Assumptions about the daily future charter rates that can be earned for hiring out the vessel (gross charter rates), about the incurred management fees and freight commissions, as well as about the utilization rate (operating days per year) must be made to forecast the (net) charter revenues accurately.
  As the development of the free cash flows for the near future can normally be forecast with a higher degree of certainty than for later years, a detailed planning period of at least 3 years should be considered. Existing charter agreements should be taken into account when forecasting the charter revenues if the charterer has a reliable creditworthiness. If no charter agreement exists or if the vessel is to be valued for a specific purpose without consideration of an existing charter agreement, (time) charter rates that can currently be observed in the market are an appropriate starting point for forecasting the charter revenues for the detailed planning period. Shipbrokers (e.g. VHSS, Harper Petersen & Co.) as well as research companies (e.g. Clarkson Research Services) provide periodically (at least monthly) actual time charter rates or time charter equivalents for different charter periods (e.g. 1, 2, 3 and 5 year duration) for a wide range of vessel types. Based on the relationship between time charter rates with different durations it is possible to derive the market expectation of the future development of charter rates. In addition, market analyses with regard to the current fleet (volume and age profile) and the additional fleet capacity (order book) as an indicator for the expected market supply as well as market analyses with regard to the economic outlook as a proxy for the expected market demand support forecasts of charter rates for the detailed planning period. An analysis of

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would have to be deducted from the LTAV. As an alternative, the market value of equity can also be determined directly by discounting the free cash flows belonging exclusively to the suppliers of equity capital (after deduction of interest and principal payments) using the cost of equity as the discount rate (so-called flow-to-equity [FTE] approach).

Charter Rates (US$/day)	Actual 2013	2014	Forecast 2015	2016	2017
Market-Implied Forecast (Clarkson)*	7,250	7,800	9,000	10,300	n/a
Research Forecast (MSI)	7,250	7,100	9,000	11,200	13,300

*based on charter contracts with different duration (1 year T/C: 7,250 US$/day, 3 year T/C: 8,400 US$/day)

Fig. 9.4 Charter rate forecast for a 1,700 TEU (geared) container vessel as of 30 June 2013

the difference of current freight rates and future freight rates (based on forward freight agreements) can also provide further indications for the future development of the charter rates in the near future. Finally, projections of future charter rates for the detailed planning period can be retrieved from research companies, e.g. Maritime Strategies International (MSI), Drewry Shipping Consultants, and Marsoft.

Figure 9.4 shows different charter rate forecasts for a geared 1,700 TEU (Twenty-foot, the T in TEU stands for Twenty-foot equivalent unit) container vessel.

Excursus: Sample market analysis: Market supply and market demand
To forecast charter rates for the detailed planning period, analyses of the current and expected market situations are important. Useful analyses should consider the fleet development (market supply) as well as the economic outlook (market demand).

Figures 9.5 and 9.6 summarize the deadweight capacity of the world cargo fleet and the volume of the order book (vessels ordered at shipyards) differentiated by main vessel types, as well as the expected increase of world trade volume, world oil demand and world GDP as of 30 June 2008 and 30 June 2013.

The analysis as of 30 June 2008 shows a substantial gap between the expected growth of market supply and market demand and thus an upcoming supply surplus. The ratio of the order book to the existing fleet less the expected scrapping rate (vessels older than 20 years as a percentage of the fleet) can be described as an indicator for the expected fleet growth. Assuming that the ordered vessels will be delivered over a period of approximately 2–3 years (up to the end of 2010), this indicator can be used as a proxy to estimate the growth of market supply up to the end of 2010. As of 30 June 2008, the projected fleet growth amounted to 43.3 % for container vessels, 32.2 % for oil tankers, and 35.2 % for bulk carriers. As opposed to this, the expected increase of world trade volume, world oil demand, and world GDP—good measures for the growth of future market demand—up to the end of

(continued)

2010 were projected to amount to 19.8, 3.7 and 8.6 % respectively. Because of the fact that from the perspective of 30 June 2008, the projected market supply growth significantly exceeded the expected market demand growth, an appraiser should have anticipated an upcoming overcapacity of vessels, leading to a significant decrease in the charter rates, as effectively seen in the last years.

Conducting the same analysis as of 30 June 2013 illustrates a substantial reduction in the gap between the projected market supply and demand growths. According to the ratio of the order book to the existing fleet and the expected scrapping rate the projected fleet growth up to the end of 2015 will amount to approximately 13.7 % for container vessels, 4.3 % for oil tankers, and 7.7 % for bulk carriers. Within the same timeframe and according to market analysts, the expected increase of world trade volume, world oil demand and world GDP will amount to approximately 13.2, 2.9 and 6.9 % respectively. In comparison to the situation in mid-2008 the gap between projected supply and demand is distinctly lower indicating no further deterioration in future charter rates. Nevertheless fleet growth is projected to remain slightly above the growth level of worldwide demand indicators for the next years. Due to this the excess capacity of vessels will probably persist. As a result, for the three vessel types—as of 30 June 2013—a continuation of the shipping crisis appears to be likely in the near future with the result that overall the charter rates will probably not improve significantly—albeit not deteriorating further—at least in the short run. The above analyses can be further broken down to the level of specific vessel size classes. For such more detailed analyses it is necessary to take into account interdependencies between different vessel size classes. Thus, for example, larger vessels are expected to replace smaller vessels on some trade routes due to economies of scale (so called "cascading" effect).

After the detailed planning period and given the cyclicality of the shipping markets with high volatility of charter rates (see Fig. 9.7), a reference to long-term historical average charter rates—at least over the last 10 years—is usually appropriate when forecasting the charter revenues far into the future. To offset extreme values it could be necessary to widen the timeframe or to select the median instead of the mean to measure the average. To verify if the assumption that history repeats itself is realistic, the specific attractiveness of the vessel in the market must be considered. For this purpose, the long-term historical average could be compared to the long-term charter rate forecasts of research companies.

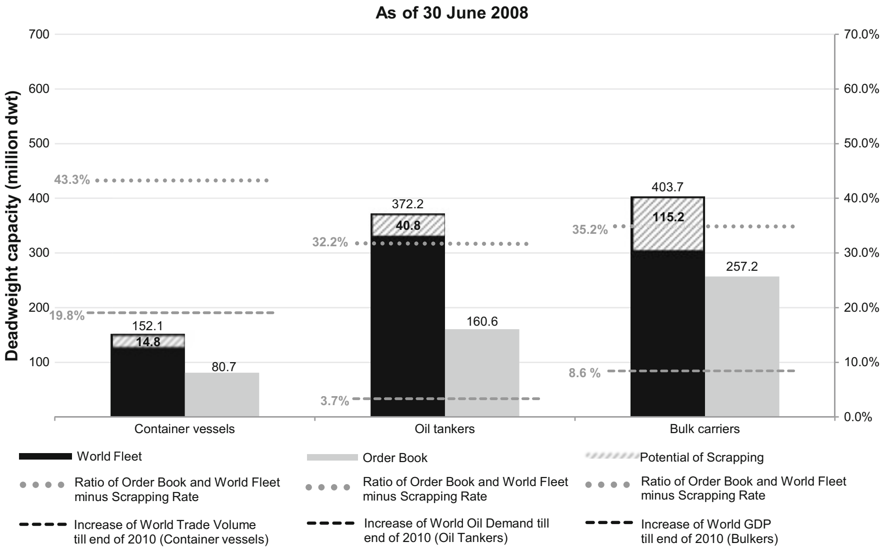

Fig. 9.5 Deadweight capacity of world cargo fleet and order book as of 30 June 2008. *Source*: Clarkson Research Services, The Economist Intelligence Unit, OPEC

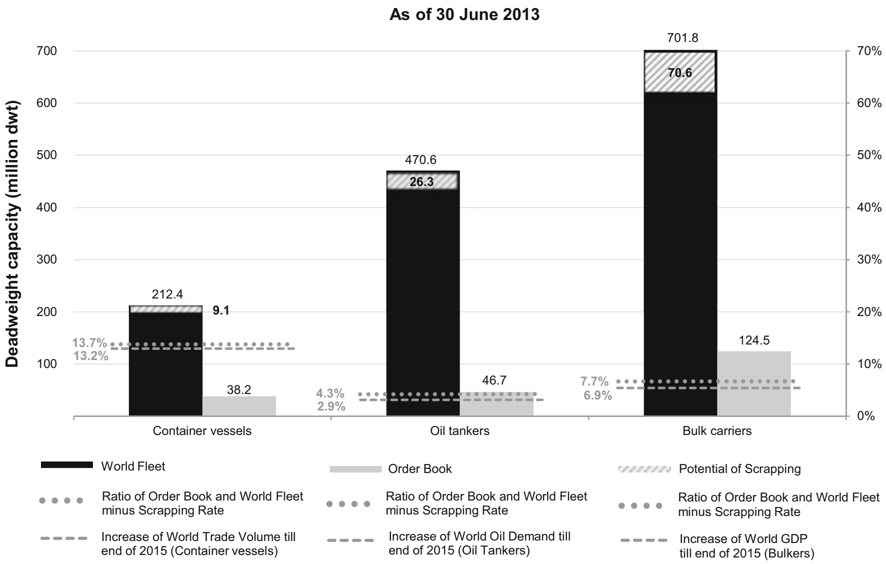

Fig. 9.6 Deadweight capacity of world cargo fleet and order book as of 30 June 2013. *Source*: Clarkson Research Services, The Economist Intelligence Unit, OPEC

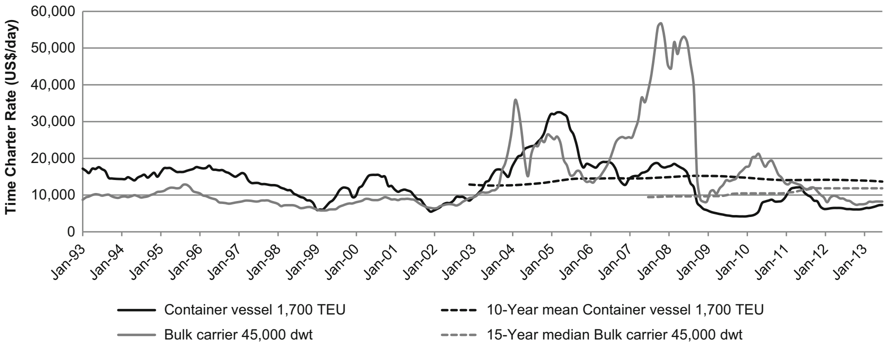

Fig. 9.7 Development of selected time charter rates (6–12 months; in $/day) between January 1993 and June 2013. *Source*: Clarkson Research Services

When forecasting the charter rates, expected increases in prices resulting from inflation should be considered to assure equivalency between the cash flow and the discount rate applied, as it is usually stated in nominal terms.[4]

Analyses of charter agreements show that compared to younger vessels older vessels often generate lower charter rates due to disadvantages in terms of efficiency (e.g. fuel consumption). This development should be reflected while forecasting charter rates. HSES recommends considering a discount when forecasting charter revenues for the periods when the vessel is older than 20 years. Experience shows that the charter rates for bulk carriers decreased by approximately 30 % and by approximately 15 % for container vessels and tankers.

Freight commissions and ship management fees are incurred when chartering. They usually amount between 1.25 and 5 % (freight commissions), respectively between 3 and 5 % (ship management fees) of the gross charter revenues.

For the estimation of the operating days of a vessel (utilization rate), a differentiation must be made between regular years of operations and years when the vessel is docked for renewing its class (normally every 5 years). In addition to the regular dry dock intervals, the forecast operating days must also take into account the other times when there is no operation (so-called off-hire times), for example, as a result of potential technical failures. HSES recommends 358 days of use in normal years and 343 days of use in class renewal years as a basis. Lower days of use might have to be taken into account due to expected additional off-hire times. The current shipping crisis has shown that due to excess capacity some vessels were not chartered and thus laid up. In such situations, a reduction of the usual utilization rate would have been reasonable.

- **Operating expenses** ($OPEX_t$)

  The operating expenses mainly include costs for personnel (e.g. crew wages and provisions), insurance, lubricants and other stores, spares, maintenance, repairs,

[4] As an alternative, an adjustment of the nominal discount rates to real discount rates is conceivable.

dockings and class renewals as well as for taxes. Payments for investments (e.g. due to environmental requirements) have to be considered as well under the operating expenses.

Due to increasing operating costs observed in the past and expected in the future, an orientation toward figures in the past when forecasting future operating costs is very questionable, contrary to the long-term forecast of charter revenues. Taking into account the current condition as well as the development of operating costs in previous years, the current operating costs should be used as a starting point for the forecast. Besides the current operating costs, the estimation in the detailed planning period should also consider expected new additional costs (e.g. investments due to environmental requirements). It must also be considered that the operating costs in class renewal years are higher by nature. For purposes of simplification, the costs for class renewals can be distributed on an annual basis. In a manner analogous to forecasting the future charter revenues, future cost increases resulting from inflation should also be taken into account while forecasting operating costs.

- **Residual value** (RV_T)

  To determine the residual value, reference to the scrap value at the end of the expected economic useful life (normally 20–25 years, Stopford 2009, p. 263) is appropriate. It is also important to take into account costs of disposal (e.g. commissions, costs of the voyage to the ship-breaking yard). When determining the scrap value, the light dis-placement weight of the vessel in (long) tons must be multiplied with the expected scrap price per (long) ton at the end of the economic useful life. As is the case with forecasting the future charter revenues and operating costs, the expected scrap value should also reflect price increases resulting from inflation.

9.4.3 Determination of the Discount Rate (WACC)

To value a vessel based on discounted cash flows, the expected free cash flows must be discounted to the valuation date using an appropriate discount rate. This rate is supposed to represent the required rate of return on an alternative investment which is equivalent to the investment in the respective vessel with regard to timing, risk, currency, and taxation of cash flows. As cash flows earned by vessels are usually denominated in USD, the discount rate should be determined as well based on US capital market data.

As the LTAV method is based on the free cash flows available for distribution among both, equity and debt suppliers of capital, the free cash flows must be discounted to the valuation date using a weighted average of required rates of return for the different sources of capital, equity, and debt. It is normally not necessary to take into account the benefit owing to the fact that interest on debt is a deductible expense for tax purposes because many important shipping nations have implemented a tonnage tax regime, where taxation is independent of the earned profits.[5] Thus, the expression of WACC is:

$$\begin{aligned} \text{WACC} = r_E \cdot \frac{E}{V} + r_D \cdot \frac{D}{V} \quad \text{where: } V &= E + D \\ r_E &= \text{Cost of Equity} \\ r_D &= \text{Cost of Debt} \\ E &= \text{Market Value of Equity} \\ D &= \text{Market Value of Debt} \end{aligned} \tag{9.2}$$

- **Cost of equity** (r_E)
  The Capital Asset Pricing Model (CAPM) is a widely accepted theory-based method for estimating the cost of equity (Sharpe 1964, pp. 425–442; Lintner 1965a, pp. 13–37; Lintner 1965b, pp. 587–615; Mossin 1966, pp. 768–783). The cost of equity can be broken down into a risk-free interest rate (r_f) and a risk premium required by the owners for the entrepreneurial risk incurred. The risk premium is derived by multiplying a general market risk premium (equity risk premium, ERP) with a specific risk factor, the so-called (equity) beta (β_E):

$$r_E = r_f + \text{ERP} \cdot \beta_E \tag{9.3}$$

  Based on the CAPM, there is a linear relationship between the required rate of equity return (cost of equity) and its systematic or non-diversifiable risk (expressed by the beta) (see Fig. 9.8).

  - **Risk-free interest rate**
    The risk-free interest rate represents the rate of return of an investment which can be earned without risk in the capital market. The risk-free nature relates to the risk in terms of currency, timing, and default (i.e. there is no uncertainty with regard to currency, the timing, and amount of the interest and principal payments).[6] As a completely risk-free investment in this narrow sense does not exist, reference to (quasi) risk-free investment alternatives such as government bonds having the highest possible credit rating is made as an approximation.[7]

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[5]Contrary to the traditional profit-based business tax, the tax basis in the case of tonnage tax is based on the tonnage and, thus, the size of the vessel. In cases of a tax regime, where taxation is dependent on profits, the expression of WACC is WACC $= r_E \cdot E/V + r_D \cdot (1-t) \cdot D/V$, whereby t is the effective tax rate.

[6]This is different from the issue about the purchase power of the interest payments and accordingly how to deal with the risk of inflation. As the projected cash flows are normally based on nominal amounts, it is not problematic if the risk-free alternative investment is subject to a risk of inflation.

[7]A negligibly small default risk is normally assumed for developed industrial nations given the best ratings by rating agencies ("AAA" from Standard & Poor's and Fitch and "Aaa" from Moody's).

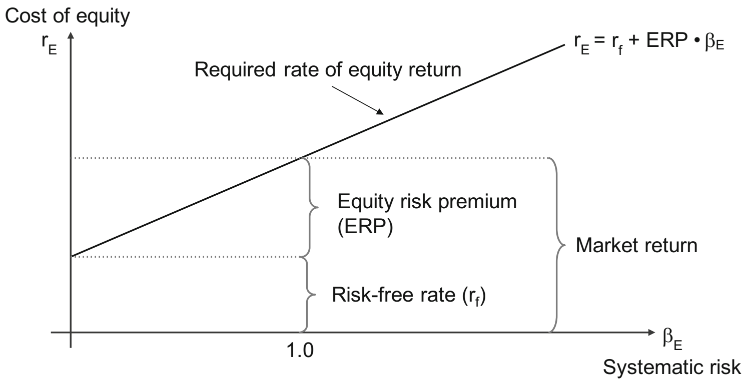

Fig. 9.8 Linear relationship between risk and return of the Capital Asset Pricing Model. *Source*: Sharpe (1964, p. 440)

Furthermore, the cash flows of the risk-free investment must be equivalent to the cash flows that are to be valued with regard to maturity to ensure identical risk exposure to changes in interest rates. In this context, preference is given to a set of zero bonds with corresponding terms to maturity. In practice, these zero bonds can only be found in the market occasionally, but interest rates of zero bonds can be mathematically derived from the observed yields to maturity for coupon-bearing bonds via an iterative procedure. A generally recognized method used by many central banks for estimating the continuous zero-coupon yield curve (term structure of interest rates) on the basis of observed yields to maturity for coupon-bearing bonds is the Nelson–Siegel–Svensson method (Nelson et al. 1985, 1987, pp. 473–489; Svensson 1994). Under this estimation method, the interest rate is defined as a variable depending on the residual maturity using the following exponential function (absolute term and various exponential terms with a total of six parameters):

$$i(m,\beta,\tau) = \beta_0 + \beta_1\left(\frac{1-e^{-\frac{m}{\tau_1}}}{\left(\frac{m}{\tau_1}\right)}\right) + \beta_2\left(\frac{1-e^{-\frac{m}{\tau_1}}}{\left(\frac{m}{\tau_1}\right)} - e^{-\frac{m}{\tau_1}}\right) + \beta_3\left(\frac{1-e^{-\frac{m}{\tau_2}}}{\left(\frac{m}{\tau_2}\right)} - e^{-\frac{m}{\tau_2}}\right) \quad (9.4)$$

In this equation, $i(m,\beta,\tau)$ refers to the interest rate for the residual maturity m in years as a function of the parameter vectors $\beta = [\beta_0, \beta_1, \beta_2, \beta_3]$ and $\tau = [\tau_1, \tau_2]$, which have to be estimated. These parameters are regularly estimated

To avoid a currency risk, the government bonds forming the basis of the risk-free interest rate must be in the same currency as the cash flows being valued.

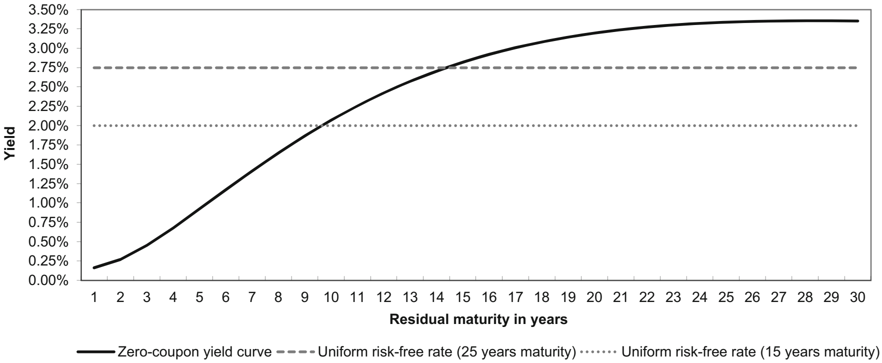

Fig. 9.9 Zero-coupon yield curve and uniform risk-free rates for different maturities as of 1 July 2013. *Source*: Federal Reserve, PwC Analysis

by various central banks[8] and published in historical sequence. If the identified interest rates for various residual maturities are illustrated in a graph, it is the zero-coupon yield curve.

Using data of the Federal Reserve the resulting interest rates are continuously compounding, while normally discrete annual interest rates are used for discounting in valuation practice. Therefore, the continuously compounding interest rates ($i_{\text{continuous}}$) must be converted to discrete interest rates (i_{discrete}) as follows:

$$i_{\text{discrete}} = e^{i_{\text{continuous}}} - 1 \tag{9.5}$$

To avoid errors in the approximation and to smooth short-term market fluctuations, reference is often made in valuation practice to average interest rates (e.g. over the last 3 months). For purposes of simplification, a uniform present value-equivalent interest rate is often determined. For example, given the yield curve parameters between April and June 2013, the following 3-month average zero-coupon yield curve and corresponding uniform risk-free rates depending on different terms to maturity result as of July 1, 2013 (see Fig. 9.9).

– **Equity risk premium (ERP)**
  The expected equity risk premium, which represents the difference between the expected return on an investment in the market portfolio[9] and the risk-free

[8]The individual parameters are determined by means of a non-linear optimization process under the criterion of minimizing the squared deviations between the estimated (theoretical) and the actually observed yields to maturity.

[9]The market portfolio theoretically consists of all risky assets including human capital, real estate, artworks, etc. and is therefore unobservable. In typical practice for valuation, the market portfolio is represented by a broad value weighted equity market index.

Table 9.1 Studies of the equity risk premium in the US

Estimation approach	Authors	Equity risk premium
Survey approach	Fernandez et al. (2012)	5.5 %
	Welch (2008)	5.0 % (geometric mean)
		5.7 % (arithmetic mean)
Historical equity risk premium	Dimson et al. (2012) 1900–2011	4.1 % (geometric mean)
		6.2 % (arithmetic mean)
	Ibbotson SBBI (2012) 1926–2011	4.7 % (geometric mean)
		6.6 % (arithmetic mean)
Implied equity risk premium	Damodaran (2012)	6.0 %

interest rate, can be determined based on *ex-post* or *ex-ante* estimates. *Ex-post*-based approaches use the average historical excess returns on investments in stocks compared to government bonds to estimate the expected equity risk premium. The calculation of the average returns is made by both arithmetic and geometric means. *Ex-ante* estimates, on the other hand, are estimates based on expected excess returns as of the valuation date. The expectations for the excess returns on investments in the market portfolio compared to government bonds are then determined based on surveys or inverted valuation models (implied equity risk premium).

Table 9.1 summarizes current empirical studies on the amount of the equity risk premium for the US capital market (Fernandez et al. 2012; Damodaran 2012; Dimson et al. 2012; Ibbotson SBBI 2012; Welch 2008).

According to these studies, the equity risk premium supposedly lies in a range of 4.0–7.0 %. Analyses indicate that in volatile market phases, the equity risk premium lies at the upper edge and in stable market phases, at the lower edge of such a range.

– **Beta** (β)

The beta measures the asset's market or systematic risk, which, in theory, is the sensitivity of the asset's returns to the returns of the market portfolio. Concretely, beta equals the covariance of the asset's returns with the returns of the market portfolio divided by the market portfolio's variance of returns:

$$\beta_i = \frac{\mathrm{Cov}(r_i, r_m)}{\mathrm{Var}(r_m)} \tag{9.6}$$

If beta is greater than one, the value of the asset reacts, on average, disproportionately high to market fluctuations. If beta is less than one, the change in value is, on average, disproportionately low.

The beta for a specific vessel is estimated using an econometric process (ordinary least squares regression) on the basis of capital market data for peer group companies listed on the stock market with a market risk comparable to that of the vessel subject to valuation.

Besides determining peer group companies and a market index for representing the market portfolio, this requires determining the length of data period and the frequency of observations. A decision must be made between the statistically desirable longest time series as possible and the necessary consistency of the business activity for the peer group companies. Longer periods of time for analysis may lead to a reduction of potential errors in the estimation and to a narrower range of beta values in the course of time, but they cannot be applied if the risk of the analyzed companies has fundamentally changed. Therefore, in valuation practice, both 2-year betas based on weekly returns and 5-year betas based on monthly returns are applied.

As the betas of the listed peer group companies also include the risks resulting from their financial leverage (capital structure risk, financial risk), they must be adjusted to reflect the operating risks only (so-called process of unlevering). This adjustment is made by calculating the unlevered betas (β_E^U) using the observed raw betas (β_E) as a basis and taking into account the debt-to-equity ratio (D/E) of the respective peer group companies. Assuming that the debt of the peer group companies is subject to credit risk, the following expression is used in financial theory:

$$\beta_E^U = \frac{\beta_E + \beta_D \cdot \frac{D}{E}}{1 + \frac{D}{E}} \tag{9.7}$$

whereby debt beta (β_D) is defined as follows:

$$\beta_D = \frac{r_D - r_f}{\text{ERP}} \tag{9.8}$$

The unlevered betas of the peer group companies then reflect the isolated degree of the operating risk arising from the economics of the industry. The unlevered beta for a specific vessel is then the median or average peer group beta.

Subsequently, the unlevered beta must be adjusted for the expected future capital structure of the vessel subject to valuation (so-called process of relevering), according to the restructured formula above:

$$\beta_E = (\beta_E^U - \beta_D) \cdot (1 + \frac{D}{E}) \tag{9.9}$$

Due to the difficulty in determining the individual debt beta values for the peer group companies, debt beta is often assumed to be zero. If this assumption is made, it is important to use the same levering formula—with debt beta equals zero—for both the process of unlevering and relevering.

- **Cost of debt** (r_D)
  Ship financing is often based on agreements of variable interest rates linked to interbank interest rates (e.g. LIBOR) plus a credit risk premium (credit spread). As a result, interest rate swaps can be referred to as starting point when

determining the cost of debt. Interest rate swaps reflect the costs for hedging the risk of a change in interest rates by swapping the variable interest rate payment to a fixed interest rate payment for the corresponding term. The amount of the credit spread depends not only on the ability to realize the value of the vessel in the case of insolvency, but also on other influencing factors, e.g. the performance of the shipping company or the existence of long-term charters with creditworthy counter-parties.

- **Capital structure** (D/E)
  Vessels are normally financed with 50–70 % debt. The capital structure is generally only of subordinate relevance for the amount of the weighted average cost of capital, as a higher level of debt leads, on the one hand, to a higher beta and to an increased rate for the cost of equity accordingly, while, on the other hand, the relative weight of equity capital in the weighted average cost of capital-formula (E/V) is lower[10] (Modigliani et al. 1958, pp. 261–297; Modigliani et al. 1963, pp. 433–443).

9.4.4 Suitability of the LTAV Method

Especially, due to the existence of pork cycles and excessive optimism and pessimism on the part of the market participants, shipping markets are characterized by exaggerated and disrupted market phases. Market prices for vessels reflected in these phases are materially influenced by short-term transactions (e.g. fire sales) and show a high degree of volatility.

The LTAV method can offset these market inadequacies at least to a certain degree by focusing on the long-term earnings potential of a vessel and, thus, also represents a reliable basis in the decision-making process of long-term investors even in phases of market exuberances. The method assumes that the suppliers of capital are acting rationally in economic terms, implying that they will provide supplemental financing if the long-term prospects are positive (expectation of generating risk-adjusted returns on investment).

The LTAV method can be applied to value vessels regardless of the market conditions. Hence, it is a necessary supplement to approaches based on transaction prices, which can be applied for vessel valuation in functioning and stable markets only.

[10] In a perfectly efficient capital market, the value of a vessel is independent of its capital structure. In this case the discount rate (WACC) equals the unlevered cost of equity according to formula 9.3 with beta being the unlevered beta according to formula 9.7. In the case of valuations of vessels, the required postulate of a perfectly efficient capital market is often not violated by income taxes which are dependent on the financing due to the predominant taxation based on tonnage. However, other market imperfections exist also in the shipping markets.

LTAV Sample Calculation

Assumptions:

Vessel Type	Container vessel	
Size	1,700 TEU	
Age	10 years	
Light Displacement	8,000 long tons	
Economic Useful Life	25 years	
Valuation Date	June 30, 2013	
Operating Days	358	
Operating Days in Years with Dry Docking	343	No Dry Docking (class renewal) at the end of economic useful life due to scrapping of vessel
Gross Charter Rate 2013 per day (p.d.)	$7,250	Current 6-12 Month Timecharter Rate as at valuation date (Source: Clarksons Research Services)
Gross Charter Rate 2014 p.d.	$7,100	Charter Rate Forecast (Source: Maritime Strategies International)
Gross Charter Rate 2015 p.d.	$9,000	Charter Rate Forecast (Source: Maritime Strategies International)
Gross Charter Rate 2016 p.d.	$11,200	Charter Rate Forecast (Source: Maritime Strategies International)
Gross Charter Rate 2017 p.d.	$13,300	Charter Rate Forecast (Source: Maritime Strategies International)
Gross Charter Rate p.d. from 2018 onwards	$13,500	10-Year Historical Average Charter Rate (Source: Clarksons Research Services)
Age Discount	15%	Reduction in the Daily Gross Charter Rate for ships over 20 years old
Fees and Commissions	6.5%	Ship Management Fees and Freight Commissions as a percentage of Gross Charter Rate
Annual Operating Expenses in 2013	$2,290,000	Operating Expenses including Tonnage Tax; Assuming Dry Docking provisions are an annual expense
Inflation Rate per annum (p.a.)	2%	Affects the Charter Rate from 2019 onwards and Scrap Value
Expected increase in Operating Expenses p.a.	3%	From 2014 onwards
Scrap Price (per long ton) as at Valuation Date	$360	Considering disposal costs; Scrap Value = Light Displacement (in lt.) x Scrap Price (per lt.) x (1+Inflation Rate)^Years
Discount Rate (WACC)	7.3%	Considering timing, risk, currency, and taxation of cash flows

Year	Ship Age (Years)	Operating Days	Daily Gross Charter Rate	Age Discount	Charter Rate after Age Discount	Fees and Commissions	Daily Net Charter Revenue	Annual Net Charter Revenue	Annual Operating Expenses	Scrap Value	Free Cash Flow	WACC	Present Value Factor	Present Value
2013	10.5	172	$7,250		$7,250	6.5%	$6,779	$1,165,945	$1,145,000		$20,945	7.30%	0.9654	$20,220
2014	11.5	358	$7,100		$7,100	6.5%	$6,639	$2,376,583	$2,358,700		$17,883	7.30%	0.8997	$16,089
2015	12.5	358	$9,000		$9,000	6.5%	$8,415	$3,012,570	$2,429,461		$583,109	7.30%	0.8385	$488,934
2016	13.5	358	$11,200		$11,200	6.5%	$10,472	$3,748,976	$2,502,345		$1,246,631	7.30%	0.7814	$974,179
2017	14.5	358	$13,300		$13,300	6.5%	$12,436	$4,451,909	$2,577,415		$1,874,494	7.30%	0.7283	$1,365,165
2018	15.5	343	$13,500		$13,500	6.5%	$12,623	$4,329,518	$2,654,738		$1,674,780	7.30%	0.6787	$1,136,735
2019	16.5	358	$13,770		$13,770	6.5%	$12,875	$4,609,232	$2,734,380		$1,874,852	7.30%	0.6326	$1,185,957
2020	17.5	358	$14,045		$14,045	6.5%	$13,132	$4,701,417	$2,816,411		$1,885,006	7.30%	0.5895	$1,111,258
2021	18.5	358	$14,326		$14,326	6.5%	$13,395	$4,795,445	$2,900,903		$1,894,542	7.30%	0.5494	$1,040,894
2022	19.5	358	$14,613		$14,613	6.5%	$13,663	$4,891,354	$2,987,931		$1,903,423	7.30%	0.5120	$974,626
2023	20.5	343	$14,905	0.0% / 15.0%	$13,787	6.5%	$12,891	$4,421,627	$3,077,569		$1,344,058	7.30%	0.4772	$641,388
2024	21.5	358	$15,203	15.0%	$12,923	6.5%	$12,083	$4,325,620	$3,169,896		$1,155,724	7.30%	0.4447	$513,993
2025	22.5	358	$15,507	15.0%	$13,181	6.5%	$12,324	$4,412,132	$3,264,992		$1,147,140	7.30%	0.4145	$475,466
2026	23.5	358	$15,817	15.0%	$13,445	6.5%	$12,571	$4,500,375	$3,362,942		$1,137,433	7.30%	0.3863	$439,369
2027	24.5	358	$16,134	15.0%	$13,714	6.5%	$12,822	$4,590,383	$3,463,830		$1,126,552	7.30%	0.3600	$405,560
2028	25.0	179	$16,456	15.0%	$13,988	6.5%	$13,079	$2,341,095	$1,783,873	$3,876,101	$4,433,323	7.30%	0.3355	$1,487,420
													LTAV	**$12,277,256**

Fig. 9.10 LTAV sample calculation for a charter-free 10-year-old 1,700 TEU (geared) container vessel

9.4.5 Sample Calculation Using the LTAV Method

The LTAV method is illustrated based on a fictitious, charter-free 10-year-old 1,700 TEU (geared) container vessel with an expected total economic useful life of 25 years. The assumptions required for the valuation as well as the determination of the LTAV are summarized in Fig. 9.10.

9.5 Possibilities for Applying the LTAV Method

9.5.1 LTAV for Investment and Divestment Decisions

The LTAV method can be used in the investment and divestment decision-making processes. Attractive investment and divestment opportunities can be identified using a comparison of the values determined based on the LTAV method and the observed market prices. Vessel prices lower than the values determined by the LTAV method represent attractive buying opportunities for a potential investor (net present value of the investment $>$ 0), while vessel prices above the corresponding LTAV indicate attractive selling prices.

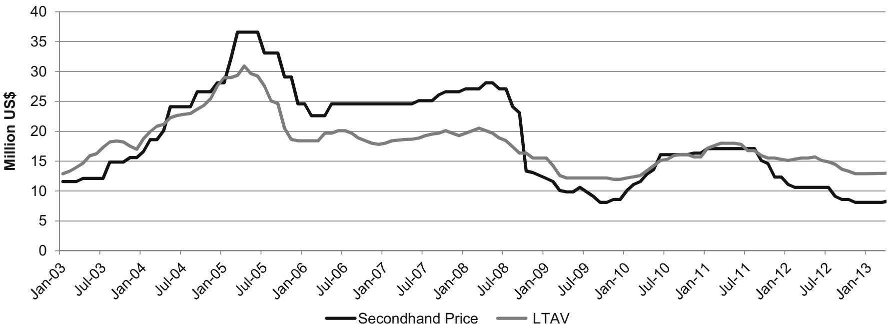

Fig. 9.11 Historical comparison of second-hand prices and theoretical LTAVs for a 10-year-old 1,700 TEU (geared) container vessel. *Source*: Clarkson Research Services, PwC Analysis

Actual market price > LTAV:	Implication for potential buyer:	Don't buy
	Implication for vessel owner:	Sell
Actual market price < LTAV:	Implication for potential buyer:	Buy
	Implication for vessel owner:	Don't sell

Figure 9.11 shows a comparison between historical market prices and theoretical values determined by the LTAV method for a 10-year-old 1,700 TEU (geared) container vessel.

Due to a more stable economic environment, the observed market prices for vessels more or less corresponded to their LTAVs from 2003 to 2004. A comparison with the LTAVs shows that higher market prices could be realized from 2005 up to mid-2008, indicating overpriced vessels. The transaction prices observed since the end of 2008 most of the time are substantially lower than the LTAVs, indicating bargain prices and corresponding high expected returns on investment.

Mispriced vessels can also be identified by comparing the internal rate of return (IRR) to the required rate of return (WACC). IRR works out the discount rate which gives a net present value (NPV) of zero. From an investor's point of view, the expected IRR can be determined by solving the following formula to IRR via an iterative procedure:

$$\text{NPV} = -\text{Actual market price} + \sum_{t=1}^{T} \frac{(C_t - \text{OPEX}_t)}{(1+\text{IRR})^t} + \frac{\text{RV}_T}{(1+\text{IRR})^T} = 0$$

$$\leftrightarrow \sum_{t=1}^{T} \frac{(C_t - \text{OPEX}_t)}{(1+\text{IRR})^t} + \frac{\text{RV}_T}{(1+\text{IRR})^T} = \text{Actual market price} \qquad (9.10)$$

If the expected IRR of the investment is higher than the risk-equivalent required rate of return (WACC), assets in the market are cheap, and the investment should be made. On the contrary, if the expected IRR of the investment is below the required risk-equivalent rate of return, assets in the market are expensive, and it should not be invested.

IRR < WACC:	Implication for potential buyer:	Don't buy
	Implication for vessel owner:	Sell
IRR > WACC:	Implication for potential buyer:	Buy
	Implication for vessel owner:	Don't sell

9.5.2 LTAV for Accounting Purposes of Vessel Owners

The LTAV method is suitable for accounting purposes, especially for impairment testing. The corresponding accounting standards of the company (e.g. US GAAP, German GAAP, International Financial Reporting Standards [IFRS], etc.) must be complied with. Consideration must be given to the fact that a central assumption in the LTAV method is the focus on the long-term earnings potential of the vessel which explicitly assumes a going concern scenario until the end of its economic useful life. In the case of a gone concern scenario, as a general rule, valuation methods based on the current market prices must be used.

According to IFRS, DCF models are accepted and commonly used for impairment testing of assets. IAS 36 (Impairment of Assets) seeks to ensure at each balance sheet date that the vessel's carrying amount is not higher than its recoverable amount, which is defined as the higher of the vessel's fair value less costs to sell and its value in use. The vessel's fair value is the amount obtainable from the sale in an arm's-length transaction between knowledgeable and willing parties. The vessel's value in use is the present value of the future cash flows expected to arise from its continuing use and from its disposal at the end of its economic useful life. As a result, this leads to a common usage of the LTAV method for accounting purposes according to IFRS.

Moreover, in other accounting and reporting standards (e.g. US GAAP, German GAAP, etc.), DCF models for the purpose of impairment testing are widely accepted.

9.5.3 LTAV for Accounting Purposes of Banks

Ship-financing banks can use the LTAV method with minor adjustments (especially the discount rate is often defined by accounting standards, e.g. the effective interest rate under IFRS according to IAS 39) to determine any need to adjust the book value of the loans receivable and to make provisions for credit losses. From a bank's perspective, the main question in the context of vessel financing is whether the expected free cash flows (the numerator in the LTAV calculation) earned by the vessel are sufficient to satisfy all payment obligations (interest and principal) including any possible additional obligations with regard to current account financing and deferrals.

In that context, the scheduled repayments of principal and the expected interest payments must be determined. Any shortfall in financing must bear interest separately and must be taken into account over the term of the financing.

If the free cash flows are not sufficient to cover all payments of interest and principal (including interest on deferred payments and any additionally required current account financing) until the end of the expected economic useful life of the vessel, the loan must be subject to allowances.

The amount of the provision for credit losses can be derived by discounting the remaining loan balance at the end of the vessel's economic useful life with the respective interest rate or by comparing the present value of the expected loan payments with the book value of the loan.

9.6 Concluding Summary

This chapter presents the basic principles of vessel valuations with a main focus on the LTAV method. In uncertain and volatile market conditions and under the assumption of a going concern scenario, vessels should be valued based on their long-term earnings potential and not on the basis of often-distorted transaction prices. The LTAV method is a appropriate method for such a income-oriented valuation approach. It is a necessary complement to the market approach for valuing vessels. The LTAV method is based on a discounted cash flow (DCF) analysis, which is already commonly used and widely accepted for the valuation of businesses and many long-lived assets (e.g. real estate, aircraft, power plants, etc.). Possibilities for applying the LTAV method are investment and divestment decisions, impairment tests for preparing financial statements, and the determination of provisions for credit losses at banks.

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