Oxera

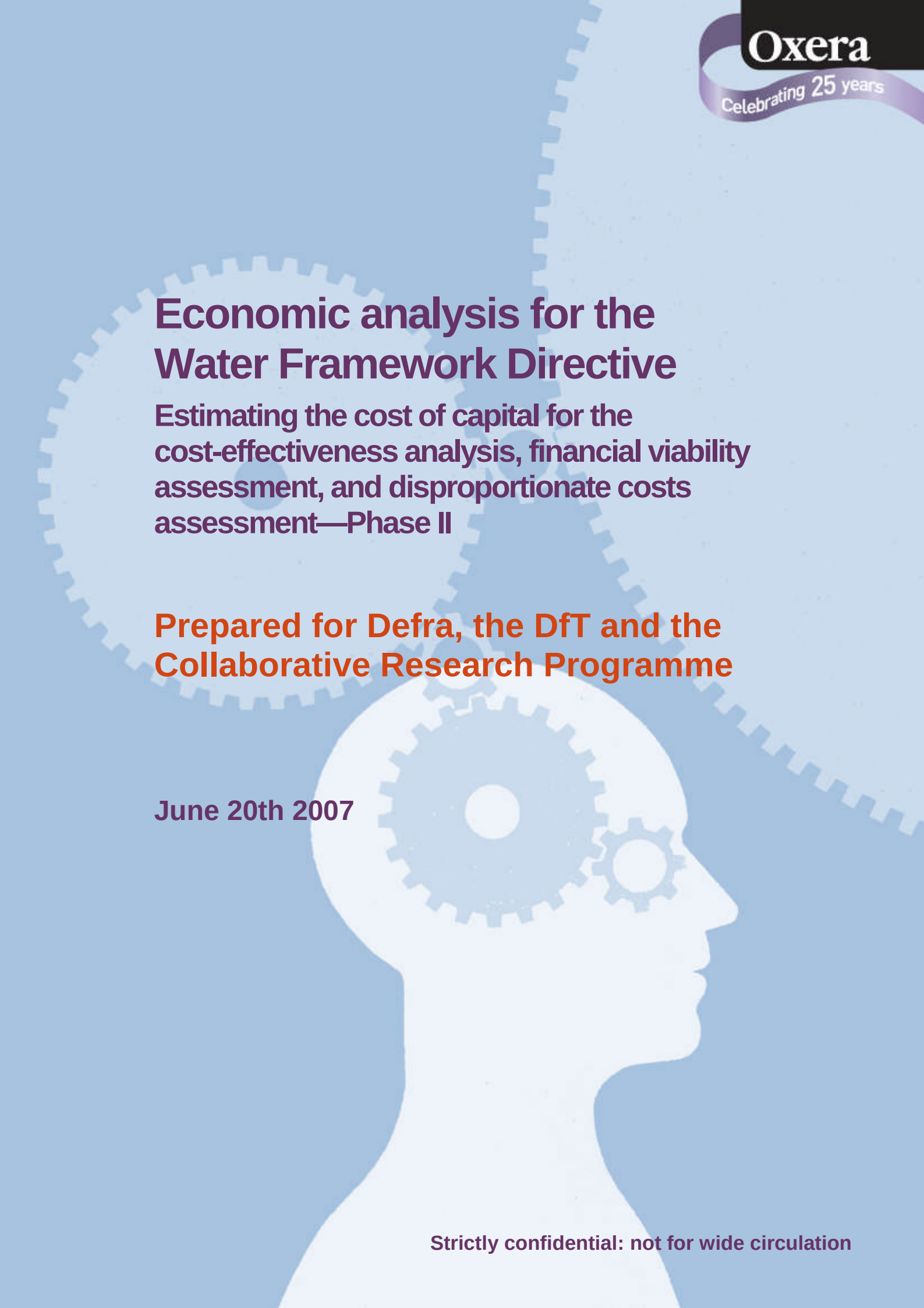
Celebrating 25 years

Economic analysis for the Water Framework Directive

Estimating the cost of capital for the cost-effectiveness analysis, financial viability assessment, and disproportionate costs assessment—Phase II

Prepared for Defra, the DfT and the Collaborative Research Programme

June 20th 2007



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1 Scope and objectives

The aim of this project is to provide an independent review of estimates of the cost of capital for a specified range of sectors in the UK. The focus of this analysis has been on reviewing the available data, existing estimates, and third-party assessments of the relevant costs of capital, as well as on the application of the capital asset pricing model (CAPM) to existing estimates of individual components of the CAPM formula. The objective of this assignment was to develop consistent and comparable estimates of the costs of capital, given the wide range of benchmarks. These estimates are developed in the context of the methodology to calculate discounted present values, as specified in Phase I. [?]

The results of the analysis presented in this report should be considered as potential, indicative range estimates for costs of capital derived from the selected sources used in this analysis, rather than as a definite set of final numbers. In each case, further adjustments to the proposed ranges might improve both accuracy and robustness, depending on the additional information available.

The key sectors of interest are:

– agriculture;
– water industry;
– urban and transport (excluding navigation);
– navigation;
– fisheries and conservation;
– mining;
– other industry/business.

Each of these was split into a number of sub-sectors. The analysis focuses on the cost of capital for the key sectors, and, where possible, the cost of capital for the indicated sub-sectors is also considered.

There is considerable ongoing debate about the best methodologies to use when estimating the cost of capital in different contexts. The application of different methodologies to different sources of data, as well as the nature of the estimation exercise, implies that specific estimates for any given industry, sector or company often vary widely. Furthermore, considering the costs of capital for smaller enterprises is especially difficult due to the lack of market data, potential additional risks faced by specific companies, and other idiosyncratic factors that are likely to affect company-specific costs of funding different projects and raising capital more generally.

Given the high-level nature of the assessment undertaken for this study, a more in-depth analysis might be required to obtain robust cost of capital estimates for individual companies.

2 Data sources and methodology

The cost of capital represents the compensation that investors require for the risk of committing capital to a project or a firm. Therefore, the quantification of the trade-off between risk and return is central to estimating the cost of capital.

Firms operating in the same sector are likely to be subject to a number of common risks (for example, due to expected similarity in the structure of their assets and costs). For this reason, it might be argued that the best estimate (given the available information) of the average cost of capital in the sector could be used as a reasonable approximation for the cost of capital of a given firm operating in this sector.

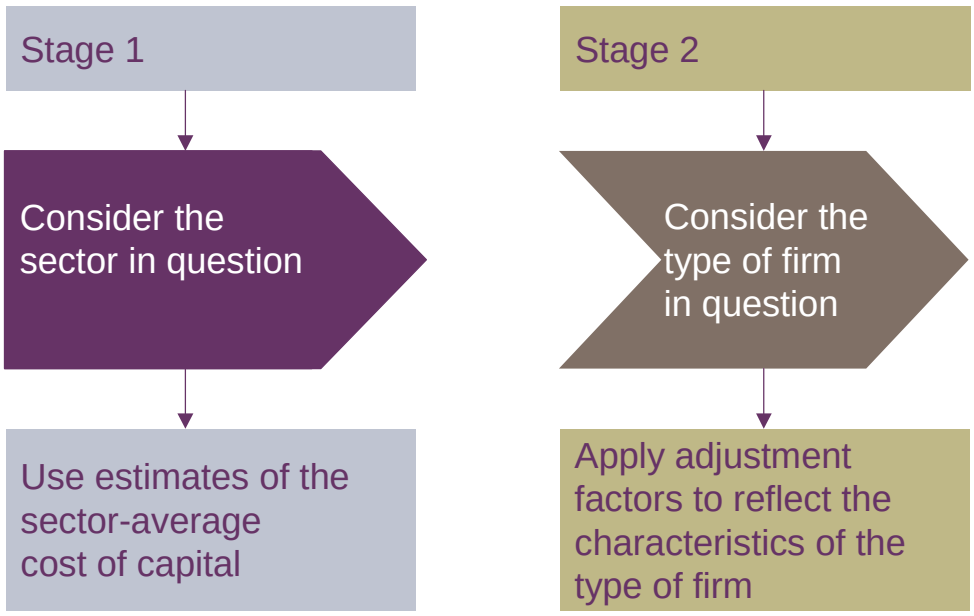
However, there are numerous potential risk factors which can mean that the cost of capital of a given firm is significantly different from the average cost of capital in that firm's sector, such as the firm having a focus on a different market segment than the average firm in the sector. Other factors include:

– *the size of the firm*: empirical research in finance has shown that there might be a premium for investing in small firms—typically referred to as the 'small-company premium';

– *constraints faced by investors in the firm*: private entrepreneurs might require premia for lack of diversification of their wealth, as well as for the potentially low liquidity of their investment.[1]

To take account of these potentially significant factors in the cost of capital estimates of firms in the selected sectors, a two-stage methodology has been developed and applied for the purposes of this study, as illustrated in Figure 2.1.

Figure 2.1 Two-stage methodology for deriving cost of capital estimates



Source: Oxera.

[1] See section 2.2 for a more detailed discussion of the premia that individual entrepreneurs might require.

The proposed methodology combines sector-average cost of capital estimates with a set of adjustments that aim to reflect specific characteristics of the type of firm for which the cost of capital estimates are required.

– In the first stage, the average cost of capital for the sector in question is considered. This serves as the basis for estimating the cost of capital for the firm in question. The set of approaches adopted in this study to estimate sector-specific costs of capital are discussed in section 2.1 below.

– In the second stage, the impact of specific characteristics of the type of firm in question on the firm's cost of capital needs to be considered (eg, size and potential constraints faced by investors). These characteristics are used to adjust the estimates of the sector-average cost of capital, derived in the first stage, to obtain more appropriate estimates that take into account some of the firm-specific characteristics.

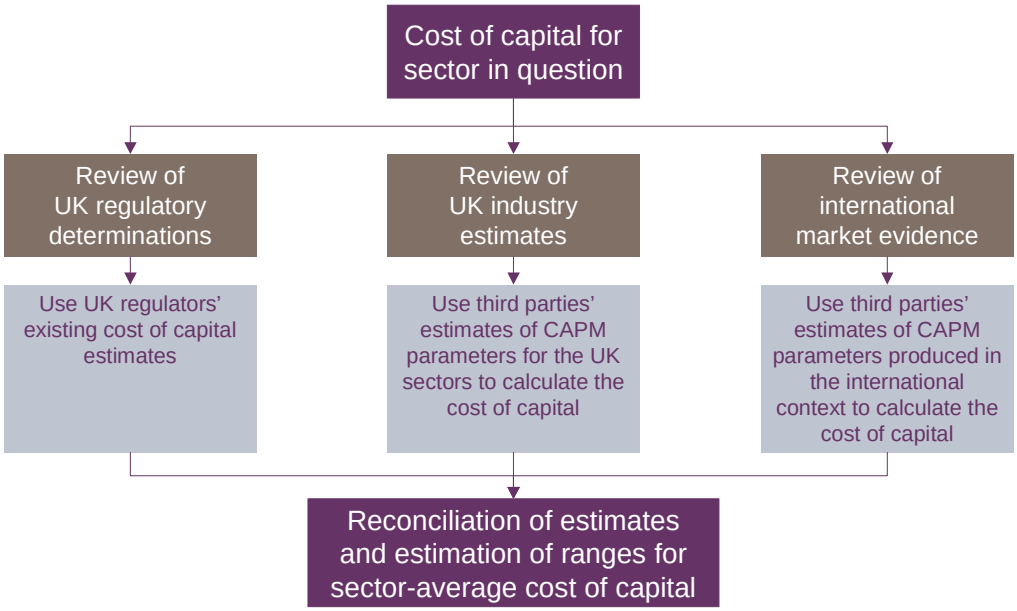
The estimates of adjustments for different types of firm are discussed in section 3.6. Importantly, these estimated adjustments need to be applied on a case-by-case basis, taking into account the set of principles discussed in section 2.2 below.

Although the detailed assessment of the cost of capital for individual firms falling under the scope of the Water Framework Directive (WFD) might yield estimates that are different from those produced using this methodology, ex ante the direction of the bias is unknown.

2.1 Estimating the sector-average cost of capital

A combination of three approaches is used in this study to derive the ranges for sector-average cost of capital estimates (see Figure 2.2).

Figure 2.2 Deriving sector-average cost of capital estimates



Source: Oxera.

2.1.1 Review of regulatory determinations

As a starting point, Oxera reviewed the regulatory cost of capital determinations for UK price-regulated sectors. These estimates were then mapped onto the list of sectors of interest, as specified in the project objectives.

A number of considerations need to be taken into account when the applicability of regulatory determinations is considered in the context of the WFD. First, there are some sectors of interest for which there are no regulatory determinations of the cost of capital. For example, it was not possible to find regulatory determinations for the UK agriculture sector.

Second, some of the existing regulatory determinations of the cost of capital might be based on assumptions that might reduce their applicability and relevance in the context of the WFD. For example, some regulators (eg, Ofwat and the CAA) use notional rather than actual gearing when setting the cost of capital. This might affect estimates of the pre-tax cost of capital through assumptions about a reasonable financial structure or implied tax allowances. While this might be appropriate for the regulatory determination of the cost of capital for regulated companies, it might not be applicable for *all* companies in the industry.

Third, although the study attempted to match as closely as possible the sectors of interest with the sectors with existing regulatory determinations, the types of firm falling under the scope of the WFD often differ from those for which regulators estimate a cost of capital in a given sector. Therefore, these estimates must be treated with caution and must be assessed on a case-by-case basis.

2.1.2 UK industry estimates

The evidence from the first approach has been supplemented by analysis of market evidence from the UK. The second approach involves the application of the CAPM to third-party estimates of individual parameters that constitute the basis for the CAPM approach (ie, the equity beta, gearing and generic parameters).

Estimates of equity betas for a selected set of firms have been obtained from the London Business School's (LBS) Risk Measurement Service; and estimates of gearing have been obtained from Datastream. This evidence was combined with estimates of the risk-free rate and the equity risk premium. The estimate of the risk-free rate used in the analysis was 2.3% and the estimate of the equity risk premium was 4.5%. This is broadly in line with the recent market evidence and regulatory determinations.

A potential drawback of this approach might include a bias towards listed firms given that Risk Management Service equity beta estimates are produced for listed firms only.

The estimates of equity betas and gearing levels were used to derive the asset betas assuming the Modigliani–Miller (MM) formula with zero debt betas. These asset betas were then used to estimate the cost of capital using the CAPM formula and assuming zero gearing.[2]

The estimates of sector-average gearing (Datastream) were used to adjust the observed equity betas (estimated by LBS) in order to derive the asset betas (un-levered equity betas). The resulting asset betas were converted into cost of capital estimates using the zero gearing assumption.

The assumption of zero gearing is made in order to simplify the analysis. According to the MM proposition, the adopted financial structure should have no impact on the cost of capital. However, in reality, a number of factors, such as the costs of financial distress or taxes, might mean that the gearing level does have implications for the cost of capital. Moreover, some firms might face constraints on the types of financial structure that they can adopt. These and other factors might need to be taken into account when applying the results of this analysis in specific circumstances.

[2] This approach gives the post-tax weighted average cost of capital (WACC).

Moreover, gearing levels might differ significantly by firm. The actual costs of debt for small and medium-sized enterprises (SMEs) are also difficult to obtain and are often influenced by idiosyncratic, firm-specific factors and the arrangements that SMEs have with their banks. For illustration, Table 2.1 presents a selection of median costs of debt for firms of different sizes. While these estimates are not explicitly incorporated into the analysis, they provide a reference point for any potential adjustments to the estimated costs of capital where such adjustments would incorporate alternative financial structures.

Table 2.1 Implicit median interest rates for large and small quoted companies, 1999 to 2001 (%)

FTSE 100	FTSE 250	FTSE Small Cap	FTSE Fledgling	AIM
7.1	7.3	8.2	8.8	8.6

Note: The implicit rate is calculated as the interest rate payments of each firm over the total amount of short- and long-term debt.
Source: Bank of England (2003), 'Finance for Small Firms—A Tenth Report', April.

According to financial theory, one of the most important factors affecting a firm's cost of capital is the level of risk associated with the firm's assets—in particular, everything else equal, the riskier the assets, the higher the cost of capital.[3] Another fundamental question in the cost of capital analysis is to what extent the adopted financing structure might have an impact on the cost of capital.

The zero gearing assumption is used in this report in order to focus the analysis on the systematic risk of assets. This approach abstracts from any specific financing structure that might be adopted by individual firms. Corporate finance theory suggests a number of reasons why the choice of a particular financing structure might affect the cost of capital.[4] In this context, the zero gearing assumption provides a useful basis for estimating the cost of capital. The impact of the choice of any particular financing structure might be considered separately in specific circumstances, in line with the adjusted-present-value method.

The benefits of higher gearing might include, for example, the ability of a firm to enjoy additional tax shields. If reflected in the cost of capital, the value of the debt tax shield would lower the cost of capital. The costs of higher gearing might include expected bankruptcy costs.[5] In particular, there might be an optimal level of gearing that is company-specific. For this level of gearing, the cost of capital is likely to be lower than that estimated under the zero gearing assumption.

Thus, Oxera's approach to gearing is conservative because it would not be expected to underestimate the cost of capital for firms in the sectors of interest compared with alternative approaches to gearing.

2.1.3 International market evidence

To supplement the evidence from the first and second approaches and to obtain cost of capital estimates for sectors where regulatory determinations are not available, third-party estimates were reviewed. This involved analysis of the cost of capital estimates for similar sectors in other countries.

[3] See, for example, Modigliani, F. and Miller, M. (1958), 'The Cost of Capital, Corporation Finance and the Theory of Investment', *American Economic Review*, June.

[4] See, for example, Miller, M. (1977), 'Debt and Taxes', *The Journal of Finance*, **32**:2; Majluf, N.S. and Myers, S.C. (1983), 'Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have', *Journal of Financial Economics*, 13:2, 187–221.

[5] See, for example, Miller (1977), op. cit.

Due to potentially different levels of risk faced by enterprises operating in different countries, the cost of capital estimates for companies outside the UK might not be directly applicable to the UK in all cases. To mitigate this potential drawback and ensure the robustness of the approach in the context of limited data availability, estimates of the cost of capital across sectors in other countries were used to calculate sector-specific asset betas, and, on the basis of these asset betas, to derive a relative ranking of sectors. The derived ranking was then applied to the asset beta of the benchmark UK sector in order to derive estimates of asset betas for other UK sectors. The resulting asset betas for the UK sectors were used to estimate the costs of capital using the CAPM formula, based on estimates for the risk-free rate of 2.3%, equity risk premium of 4.5% and an assumption of zero gearing.[6]

This approach is based on the underlying assumption that, although the levels of sector-average costs of capital might differ across countries, the relative positioning of sectors in terms of their costs of capital is likely to be similar.

The potential drawback of this approach is the possible mismatch between the types of firm operating in sectors of interest for the WFD and those operating in sectors for which third-party estimates are available. To mitigate this drawback, the study has sought to match the two groups of sectors as closely as possible.

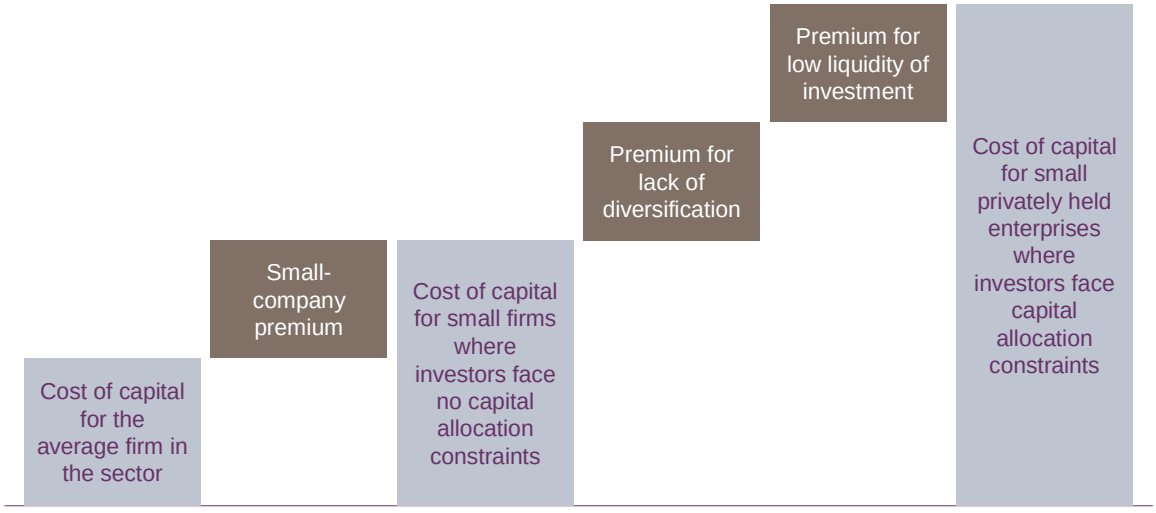
2.1.4 Reconciliation

The results of the three approaches are combined to derive ranges of cost of capital estimates for the sectors of interest.

2.2 Adjusting for the specific characteristics of the type of a firm

The types of firm falling under the scope of the WFD might have a number of characteristics that could imply significant differences between the sector-average costs of capital and the cost of capital of individual firms. Once these characteristics are identified and quantified, the sector-average cost of capital estimates might be fine-tuned on a case-by-case basis, to reflect the specific characteristics of the types of firm under examination. This process is illustrated in Figure 2.3 and described in greater detail below.

Figure 2.3 Adjusting the average cost of capital estimates



Source: Oxera.

[6] The choice of the risk- free rate and the equity risk premium is for illustrative purposes only and does not necessarily reflect the risk-free rate and the equity risk premium estimates that might be appropriate in different contexts. This approach gives the post-tax weighted average cost of capital (WACC). For zero gearing, the post-tax WACC is equivalent to the 'vanilla' WACC.

First, financial markets may require a premium for providing capital to small companies—the small-company premium, as mentioned above. This premium could reflect the following three broad components:

– an equity return premium, to compensate for higher trading costs (including the cost of lower liquidity);
– an interest rate premium on the cost of debt finance; and
– premia on the costs of raising capital (for both debt and equity).

Second, certain characteristics of privately owned small enterprises might further increase their costs of capital over and above the impact of the small-company premium mentioned above. These characteristics might include the following.

– For private enterprises, a substantial share of entrepreneurs' total wealth is likely to be invested in the firm. Thus, private entrepreneurs may not be fully diversified and might require a premium for this lack of diversification compared with standard CAPM estimates.

– Stakes in private enterprises might not be easily transferable. Therefore, a premium might be required for the low liquidity of entrepreneurs' investments. It can be argued that this premium is required over and above the premium for higher trading costs, which forms part of the small-company premium.[7]

The small-company premium, the premium for lack of diversification, and the premium for holding illiquid investments are assumed to be related to the cost of equity in this context. Given the assumption of 100% equity, these premia are effectively applied to the cost of capital.

The assumption of zero gearing could be further justified for small private enterprises on the basis of the type of financing that such companies commonly adopt. In particular, entrepreneurs might borrow using personal assets as security. This might reduce the conceptual boundaries between entrepreneurs' cost of equity and their cost of debt. It might also suggest that the premium to entrepreneurs' cost of equity for their inability to diversify could reflect the higher cost of debt for smaller private enterprises.

[7] The premium for higher trading costs, which forms part of the small-company premium, reflects the difference in liquidity of different publicly traded stocks (eg, frequently relative to thinly traded stocks), while the premium for low liquidity, required by small private enterprises, reflects the difference in liquidity between traded stocks and stocks with no secondary market. Any potential overlap is likely to be small.

3 Cost of capital estimates

This section summarises the results of the three approaches to estimating the sector-average costs of capital for the list of sectors and sub-sectors submitted by Defra to Oxera for consideration in the context of WFD. Further details regarding the three approaches can be found in the appendices. The reported estimates are the real post-tax WACC. For zero gearing, as assumed in the calculations, these are also equivalent to the vanilla WACC because both exclude the benefits of debt tax shields.

The cost of capital estimates for the main sectors listed in section 1 are summarised in sections 3.1 to 3.4. Section 3.5 provides the cost of capital estimates for some of the selected sub-sectors for which data was available.

3.1 UK regulatory determinations for key sectors

Table 3.1 presents estimates of the cost of capital based on regulatory determinations.

Table 3.1 Cost of capital estimates based on regulatory determinations (%)

Sector	WACC (real, post-tax)	Source
Agriculture	n/a	n/a
Water industry	5.00–5.80	Water and sewerage companies (Ofwat, November 1999 and December 2004)
Urban and transport (excluding navigation)		
Road, air and rail transport	6.75[1]–6.9	Network Rail (ORR 2003), BAA (CAA 2003)
Navigation	n/a	n/a
Fisheries and conservation	n/a	n/a
Mining	n/a	n/a
Other industry/business	n/a	n/a

Note: [1] In 2003 the range for the allowed rate of return for Network Rail was 6.5–7.0% on a pre-tax basis. The ORR suggested that Network Rail would be likely to make much lower tax payments than other regulated businesses. This implies that the post-tax allowed rate of return is likely to be similar to the pre-tax allowed rate of return.
Source: Ofwat (2004), 'Future water and sewerage charges 2005–10: Final determinations', December. Ofwat (1999), 'Future water and sewerage charges 2000–05: Final determinations', November. ORR (2003), 'Access charges review: final conclusions', December. CAA (2003), 'Economic regulation of BAA London Airports (Heathrow, Gatwick and Stansted) 2003–2008 CAA decision', February.

3.2 UK industry estimates

Table 3.2 below presents cost of capital estimates based on UK market evidence. The analysis involved two stages: estimate asset betas and then apply the CAPM formula to these estimated asset betas. Asset betas were derived from the equity betas as reported by

the Risk Management Service and gearing estimates as reported by Datastream.[8] The derived asset betas were used to estimate the cost of capital using the CAPM methodology.

To estimate the cost of capital using the CAPM, the asset betas need to be combined with the risk-free rate and the equity risk premium.

Table 3.2 Cost of capital estimates based on the CAPM (%)

Sector	WACC (real, post-tax)
Agriculture	4.7–4.8
Water industry	3.5–3.8[1]
Urban and transport (excluding navigation)	
Road, air and rail transport	4.7–5.0
Navigation	
Commercial shipping, ports	4.0–5.7
Fisheries and conservation	3.8–3.9
Mining	4.5–6.4
Other industry/business	
Chemical and oil industry	4.5–5.0

Note: In each case the range for the real post-tax WACC cost of capital estimates is based on the asset betas estimated using Risk Management Service equity betas and Datastream gearing estimates, a risk-free rate of 2.3%, equity risk premium of 4.5% and assuming zero gearing. [1] These cost of capital estimates for the water industry are based on point estimates of equity betas obtained using current evidence from financial markets (LBS beta estimates). It is possible that this data might produce biased estimates of the cost of capital for a number of reasons. For example, it might fail to appropriately take into account a number of factors potentially affecting the cost of capital, such as historical developments in financial markets. Also, it might ignore significant uncertainty around point estimates. For example, according to Smithers & Co. (2006), the uncertainty around the point estimate of equity beta for utilities is such that the hypothesis that equity beta equals unity could not be rejected. (See Smithers & Co. Ltd., 'Report on the Cost of Capital provided to Ofgem', 2006.) Furthermore, the use of the CAPM ignores empirical evidence suggesting that there might be several factors other than beta that might affect the cost of capital. To take account of these considerations, the regulators have used more sophisticated estimation techniques in practice.
Source: LBS Risk Measurement Service, Datastream and Oxera analysis.

3.3 International market evidence

For comparison, Table 3.3 below summarises the cost of capital estimates derived from the analysis undertaken in the international context. These reference estimates are based on the following sources:

– results of a study on the cost of capital across a number of sectors in New Zealand;[9]
– estimates of asset betas for a number of sectors in the USA, as reported by Professor A. Damodaran;[10]
– estimates of asset betas for a number of sectors in EU Member States, as well as Switzerland and Norway, based on Datastream.[11]

[8] LBS, Risk Measurement Service.
[9] PricewaterhouseCoopers (2006), 'The cost of capital report'.
[10] 'Damodaran Online' (available at http://pages.stern.nyu.edu/~adamodar/).
[11] Ibid.

Table 3.3 Cost of capital estimates based on third-party analysis (%)

Sector	WACC (real, post-tax)
Agriculture	3.9–7.3
Water industry	4.3–5.6
Urban and transport (excluding navigation)	
Road, air and rail transport	3.7–6.3
Navigation	
Commercial shipping, ports	4.0–5.7
Fisheries and conservation	5.6–6.1
Mining	5.6–7.5
Other industry/business	4.7–9.8

Note: The range for the real post-tax WACC is based on asset beta estimates for New Zealand, the USA and EU Member States, using a risk-free rate of 2.3%, equity risk premium of 4.5% and assuming zero gearing.
Source: Value line and Datastream, as reported by Professor A. Damodaran, 'Damodaran Online' (available at http://pages.stern.nyu.edu/~adamodar/); PricewaterhouseCoopers (2006), 'The cost of capital report'.

The UK benchmark sector for asset betas for EU and US sectors was 'Water industry'.[12] The asset beta for the UK water sector (0.45) was estimated using an equity beta of 1 and notional gearing of 55%, as reported in Ofwat (2004).[13]

The UK benchmark sector to which the ranking of sectors in New Zealand by asset beta was applied is 'Urban and transport (excluding navigation)'.[14] The UK asset beta estimate for that sector (0.675) was estimated as the asset for BAA, as set by the CAA in 2003 for the fourth periodic control period.[15]

3.4 Reconciliation of average cost of capital estimates for key sectors

The results of the three approaches applied to estimate the costs of capital for the sectors identified in sections 1 and 2 are combined into a single range, as shown in Table 3.4. For a given sector, the lowest estimate across the three approaches was taken as the lower end of the final range, while the highest was taken as the upper end of the final range.

[12] It might be argued that the water industry is characterised by less cross-country risk variability than other sectors of interest for this study.
[13] Ofwat (2004), 'Future water and sewerage charges 2005–10: Final determinations', December.
[14] Because asset beta estimates for the water sector in New Zealand were not available, the transport sector was used as the benchmark sector to derive relative ranking of sectors.
[15] CAA (2003), 'Economic regulation of BAA London Airports (Heathrow, Gatwick and Stansted) 2003–2008 CAA decision', February.

Table 3.4 Summary of cost of capital (real, post-tax %) estimates for the key sectors

Sector	Using the three approaches
Agriculture	3.9–7.3
Water industry	3.5–5.8
Urban and transport (excluding navigation)	3.7–6.9
Navigation	4.0–5.7
Fisheries and conservation	3.8–6.1
Mining	4.5–7.5
Other industry/business	4.5–9.8

Source: Review of regulatory determinations, third-party estimates, LBS Risk Measurement Service, and Datastream.

3.5 Cost of capital estimates for sub-sectors

The three approaches to estimating the costs of capital for the key sectors were also employed to estimate the costs of capital for a number of sub-sectors within each of the key sectors, where data was available. For example, explicit estimates of asset betas for 'Poultry' derived in the international context (see Table 3.5 below) were used to estimate the cost of capital for 'Poultry' based on the third approach described above. Similarly, where the data is available at the sub-sector level, other approaches were also applied.

Table 3.5 Summary of cost of capital estimates for sectors and sub-sectors (real, post-tax WACC, %)

Sector	Regulatory determinations	UK industry estimates	International market evidence	Summary
Agriculture				3.9–7.3
All	n/a	4.7–4.8	7.2–7.3	4.7–7.3
Poultry	n/a	n/a	5.3	5.3
Forestry		n/a	3.9–5.6	3.9–5.6
Water industry	5.0–5.8	3.5–3.8	4.3–5.6	3.5–5.8
Urban and transport (excluding navigation)				3.7–6.9
Road, air and rail transport	6.75–6.9	4.7–5.0	3.7–6.3	3.7–6.9
Navigation				4.0–5.7
Ports	n/a	n/a	4.0–4.7	4.0–4.7
Commercial shipping/boating	n/a	4.7–5.0	5.3–5.7	4.7–5.7
Fisheries and conservation	n/a	3.8–3.9	5.6–6.1	3.8–6.1
Mining	n/a	4.5–6.4	5.6–7.5	4.5–7.5
Other industry/business				4.5–9.8
Chemical and oil industry	n/a	4.5–5.0	5.5–9.8	4.5–9.8
Construction	n/a	n/a	4.8–6.5	4.8–6.5
Waste management	n/a	n/a	4.7–5.3	4.7–5.3
Recreation not covered by boating or angling (eg, parkland/amenities)	n/a	n/a	4.7–6.2	4.7–6.2

Source: Third-party estimates, LBS Risk Measurement Service.

This analysis indicates that the regulatory determinations of the cost of capital are often above the cost of capital estimates based on market data. The regulatory determinations might nevertheless be appropriate in light of problems with cost of capital estimates based on market data. This is partly driven by market volatility and significant inherent uncertainty in any point estimates derived from volatile data, as well as by potential temporary market deviations from fundamental equilibrium that might provide biased cost of capital estimates. For this reason, the regulators often consider factors in addition to market evidence when setting regulatory determinations. This could explain the difference between cost of capital estimates based on market evidence and the regulatory determinations.

3.6 Adjustments for firm-specific factors

This section presents estimates of the adjustments that are required in order to implement the second stage of the methodology presented above. The adjustments discussed below need to be added to the estimates of the sector-average costs of capital in order to take into account factors such as the small-company premium and the potential constraints on investors in small, privately held enterprises.

3.6.1 Small-company premium

Empirical research in finance indicates that financial markets generally require a premium for investments in small companies.[16] Estimates of this premium in the UK context are shown in Table 3.6.

Table 3.6 Estimates of the small-company premium in the UK (%)

Source of evidence	Period	Premium
Levis (1985)	1958–82	0.40
Dimson and Marsh (1999)	1955–88	0.49
Strong and Xu (1995)	1973–92	0.61

Source: Van Dijk, M.A. (2006), 'Is Size Dead? A Review of the Size Effect in Equity Returns', RSM Erasmus University, May, pp. 42–3.

Further evidence can be obtained from the UK regulated sectors. For example, Ofwat has applied a small-company premium to the cost of capital of water-only companies, ranging from 0.3% to 0.9% depending on the company size.[17] The relationship between the small-company premium and the company size in this context is presented in Table 3.7.

Table 3.7 Ofwat's bands for the small-company premium, 2004 (%)

Regulatory capital value	Small-company premium (gross of tax shield)
<£70m	0.9
£70–£140m	0.8
£140–£250m	0.7
£280–£700m	0.3

Source: Ofwat (2004), 'Future water and sewerage charges 2005–10: Final Determinations', December.

The results of the regulatory determinations presented above suggest that a premium of around 0.3–0.9% would need to be applied to the cost of capital of small companies. As indicated, the choice of the size of the premium for a specific type of firm could be based on its size. This might be particularly relevant given that some recent evidence points to a rising relative cost of capital of SMEs in recent years.[18]

3.6.2 Premium on the cost of capital of small private enterprises

Small private enterprises might require a further premium over and above the small-company premium. As discussed in section 2, this is typically associated with the premium that private entrepreneurs might require to compensate them for their inability to diversify, as well as for the illiquidity of their stakes in the enterprise (for example, due to the absence of a secondary market).

[16] Fama, E. and French, K. (1992), 'Common Risk Factors in the Returns on Stocks and Bonds', *Journal of Financial Economics*, **1**, 43–66.

[17] Not only do regulators allow companies to earn the small-company premium where appropriate, but there are also precedents when the Competition Commission has included a small-company premium in the estimate of the cost of capital. For example, in the home credit investigation, the Commission noted a number of reasons why there might be a premium on the cost of debt and equity for small firms. Among these, it includes the reason that there might be less publicly available information for investors (see Competition Commission, 'Home credit market investigation—Annex 3.5' November 2006.

[18] HM Treasury (1998), 'Smaller Quoted Companies, A Report to the Paymaster General, November, p. 20.

Premium for entrepreneurs' inability to diversify

As a significant share of entrepreneurs' total wealth might be invested in their enterprises, they might not be able to fully diversify their investments. Empirical evidence indicates that the required returns are negatively correlated with the level of diversification by the investor.[19]

Empirical estimates suggest that if the value of the owner's equity investment in a private company, relative to the net worth of the owner of that company,[20] were to increase by 10 percentage points, the return on equity would increase by around 9.0–9.2 percentage points.[21] Moreover, evidence from academic studies suggests that the expected return required by an investor to invest in a private business lies around 0.4–1.2% above a fully diversified benchmark.[22]

Further empirical estimates of the premium required by under-diversified investors, segmented by firm size, are shown in Table 3.8.

Table 3.8 Estimates of the premium for the inability to diversify, segmented by the percentage of the entrepreneurs' wealth invested in the venture (%)

	100%	35%	25%	15%
Size of the firm				
0–25 employees	5.66	4.57	4.00	3.01
26–100 employees	4.88	3.98	3.51	2.70
Over 100 employees	3.30	2.69	2.39	1.89
All observations	**3.44**	**2.73**	**2.39**	**1.86**

Source: Kerins, F., Smith, J.K. and Smith, R. (2003), 'Opportunity Cost of Capital for Venture Capital Investors and Entrepreneurs', February, p. 48, Claremont Graduate University Working Paper.

This evidence suggests that even with modest levels of under-diversification, the cost of capital for private enterprises would be substantially higher than that for a company with well-diversified investors (eg, a company which can raise funding from capital markets).

The premium for the lack of diversification might range from 1.86% to 5.66%.[23] The choice of the premium to be applied to a particular type of a firm could be based on size (eg, in terms of the number of employees) or the degree of the entrepreneur's commitment to the firm (in terms of the percentage of wealth invested in the business).

To provide further estimates of the premium required to compensate investors for their lack of diversification, empirical evidence on the returns required by corporate executives can be examined. Evidence from the financial markets suggests that, since managers are unlikely to be fully diversified, they will value any stock- or equity-based compensation at less than its market value. The estimates of the premium required by under-diversified individuals are illustrated in Table 3.9 below.

[19] Merton, R. (1987), 'A simple model of capital market equilibrium with incomplete information', *Journal of Finance*, **43**, 483–510. Fu, F. (2005), 'Idiosyncratic risk and the cross-section of expected stock returns', June, University of Rochester, March. Goetzmann, W.N. and Kumar, A. (2005), 'Why do individual investors hold under-diversified portfolios?', Yale University and University of Notre Dame, April. Ang, A., Hodrick, R.J., Xing, Y. and Zhang, X. (2004), 'The Cross-Section of Volatility and Expected Returns', Columbia University, Rice University and Cornell University, March. Muller, E. (2004), 'Underdiversification in Private Companies—Required Returns and Incentive Effects', Centre for European Economic Research, Discussion Paper No. 04–29.

[20] The net worth of the owner is defined as the sum of the owner's personal assets minus their personal liabilities.

[21] Muller, E. (2004), 'Underdiversification in Private Companies—Required Returns and Incentive Effects', Centre for European Economic Research, Discussion Paper No. 04–29, p. 28.

[22] Polkovnichenko, V. (2002), 'Human Capital and the Private Equity Premium', University of Minnesota and the Federal Reserve Bank of Minneapolis, April.

[23] Kerins et al. (2003), op. cit, p. 31.

Table 3.9 Estimates of the premium for the inability to diversify, segmented by percentage of the investment portfolio constrained to a single stock (%)

Percentage of the investment portfolio constrained to a single stock	Median return premium (%)
100	8
75	6
50	5
25	2

Source: Meulbroek, L.K. (2000), 'The Efficiency of Equity-Linked Compensation: Understanding the Full Cost of Awarding Executive Stock Options', Harvard Business School, pp. 35 and 40.

This evidence suggests that the premium for the lack of diversification might range from 2% to 8%, depending on the percentage of wealth invested in the business. Combining this evidence with the evidence from Table 3.8 above, the premium for the lack of diversification might range from 1.86% to 8%, depending on the size of the firm and the percentage of wealth invested in the business.

Premium for low liquidity of entrepreneurs' stakes

Entrepreneurs' stakes in private enterprises are not easily transferable compared with publicly traded securities, for which there exists a secondary market. As shown in Table 3.10, the premium (in the form of higher returns) required by investors to invest in illiquid assets might be 0.5–3.3%. This range is derived from the market for equity index-linked bonds, which provide the same payments as an investment in an equity index, but are relatively illiquid.

Table 3.10 Estimates of the premium for illiquidity (%)

	Index to which the equity index bond is linked			Average
	All-share	Europe (excluding the UK)	Small cap (excluding IT)	
Institutional investor	0.48–0.63	1.19–1.50	2.31–2.40	1.33–1.51
Retail investor	1.38–1.53	2.09–2.40	3.21–3.30	2.23–2.41

Source: Dimson, E. and Hanke, B. (2002), 'The Expected Illiquidity Premium: Evidence from Equity Index-Linked Bonds', December, LBS, p. 2.

3.6.3 Summary of estimates

The review of empirical evidence provides the following potential quantification of the approximate premia on the average costs of capital required by investors in small firms and private enterprises.

Table 3.11 Summary of estimates of the premium required by small companies and private enterprises (%)

Uplift for	Range
Small firms	**0.3–0.9**
Private enterprises (in addition to the small-company premium)	**2.34–11.30**
Premium for lack of diversification	1.86–8.0
Premium for low liquidity of investments	0.48–3.30

Source: Review of third-party estimates.

4 Conclusions

This report has proposed a two-stage methodology that might be applied in order to derive an estimate of the cost of capital for a particular type of a firm falling under the scope of the WFD.

First, the appropriate sector for this firm needs to be identified and the sector-average cost of capital needs to be determined. Examples of such estimates are presented in Table 3.5 and serve as the starting point of the assessment.

Second, the firm's specific characteristics need to be examined and taken into account by determining firm-specific adjustments to the sector cost of capital. The potential relevant characteristics include, but might not be limited to, the firm's size (eg, total assets or number of employees), and the degree of investor commitment to the firm (ie, the percentage of total wealth invested in the business). Once the specific characteristics of a given firm have been identified, the impact of these characteristics on the cost of capital needs to be quantified. Examples of the relevant adjustments to the cost of capital are shown in Table 3.11.

4.1 Stylised example

The application of the proposed methodology is illustrated below using a stylised example. The hypothetical case involves two firms that are expected to deliver the same environmental outcome. The first firm is assumed to have characteristics consistent with a higher cost of capital than the second firm. At the same time, the first firm is able to deliver the same environmental outcome as the second firm with lower CAPEX and OPEX. Thus, the example illustrates the trade-off between a higher cost of capital, which increases the present value of social costs, and lower CAPEX, which decreases the present value of social costs.

For example, the first firm could be thought of as a less well established but more innovative firm, which is riskier (has a higher cost of capital), but exhibits greater cost efficiency (lower CAPEX and OPEX for the same environmental outcome).

4.1.1 Step 1: Cost of capital

The cost of capital calculation is shown for two hypothetical firms with characteristics as shown in Table 4.1.

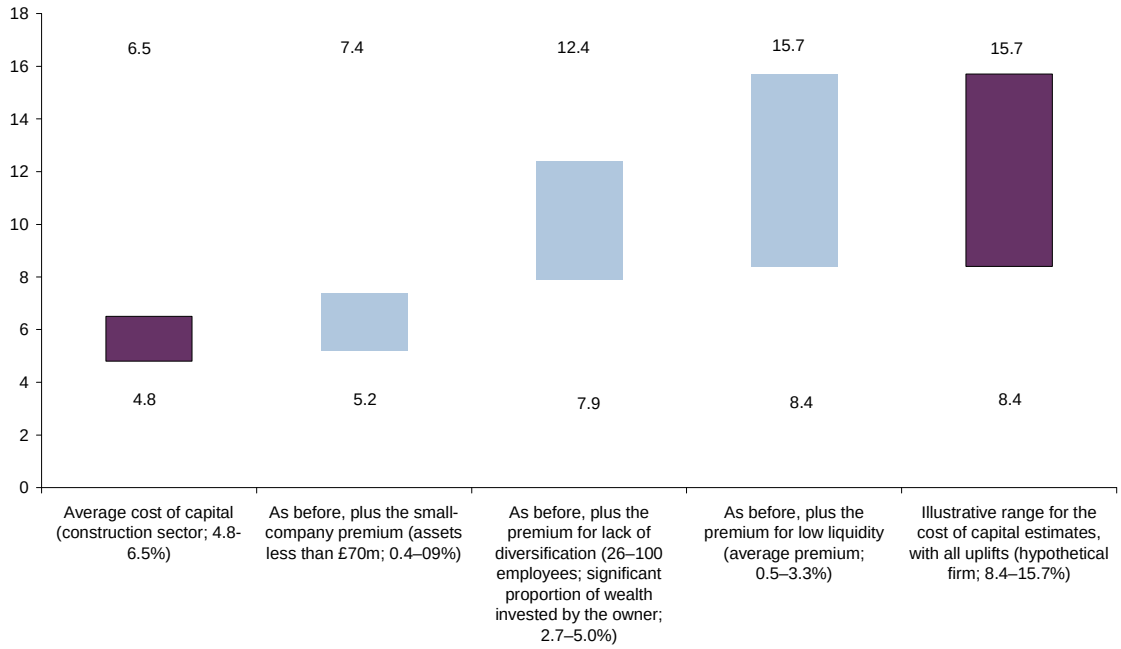
Table 4.1 Characteristics of two hypothetical firms for the illustrative cost of capital estimation

	Firm 1	Firm 2
Sector	Construction	Ports
Value of fixed assets (£'000)	40,000	100,000
Number of employees	26–100	Over 100 employees
Number of private owners	1	2
Annual revenue (£'000)	4,000	8,000

Source: Oxera.

The example of the process for estimating the appropriate cost of capital for the first firm is shown in Figure 4.1 below.

Figure 4.1 A range of the potential cost of capital (real, post-tax) estimates for a hypothetical firm



Source: Oxera.

The resulting range for the cost of capital estimate for the first firm is 8.4–15.7%, with a midpoint of 12.1% (post-tax, real). The application of this approach to the second firm would yield a cost of capital range from 6.8% to 11.5%, with a midpoint of 9.2%.

4.1.2 Step 2: Calculation of the present value of costs

In the second step, the ranges for the costs of capital obtained in the first step are used to estimate the present value of costs of delivering a certain environmental outcome. This example follows the methodology presented in Oxera's final report of Phase I.[24]

Details of the expenditure required for the hypothetical firms to deliver the same environmental outcome are summarised in Table 4.2 below.

[24] Oxera (2006), 'Economic analysis for the Water Framework Directive: discounting and the calculation of the present value', October.

Table 4.2 Characteristics of the investment project required to deliver the environmental outcome

	Firm 1	Firm 2
Initial capital investment (£'000)	1,000	1,050
Annual operating costs (excluding depreciation) (£'000)	10	10
Life of the project (years)	6	6
Period over which CAPEX is recovered from consumers (years)	6	6
Basis for CAPEX recovery	Straight line over 6 years	Straight line over 6 years
Marginal corporation tax rate, CAPEX (%)	28	
Social discount rate (%)	3.5	
Estimated cost of capital (midpoint, %)	12.1	9.2

Source: Oxera.

Using this information, it is possible to compare the discounted present value of social costs of the environmental outcome, calculated in accordance with the methodology proposed in Phase I, when the first firm is required to deliver the project with that where the second firm delivers it (see Table 4.3).

Consistent with the methodology proposed in Phase I, the cost of capital estimates—used in this example to calculate the social cost of the policy—represent the post-tax WACC. Also, according to the methodology, corporation tax should not be included in the social costs of the environmental outcome.

Table 4.3 Stylised example of the calculation of the present value of the environmental outcome (£'000)

Year	Today	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Nominal costs of the policy								
CAPEX								
Firm 1	1,000							**1,000**
Firm 2	1,050							**1,050**
OPEX								
Firm 1		10	10	10	10	10	10	**60**
Firm 2		10	10	10	10	10	10	**60**
Total nominal costs								
Firm 1								**1,060**
Firm 2								**1,110**
Social costs of policy								
OPEX recovery								
Firm 1		10	10	10	10	10	10	**60**
Firm 2		10	10	10	10	10	10	**60**
CAPEX recovery								
Firm 1		167	167	167	167	167	167	**1,000**
Firm 2		175	175	175	175	175	175	**1,050**
Compensation for CAPEX-related risk								
Firm 1 (post-tax cost of capital of 12.1%)		121	101	81	61	40	20	**424**
Firm 2 (post-tax cost of capital of 9.2%)		97	81	64	48	32	16	**338**
Total CAPEX								
Firm 1		288	268	247	227	207	187	**1,424**
Firm 2		272	256	239	223	207	191	**1,388**
Total policy costs								
Firm 1		298	278	257	237	217	197	**1,484**
Firm 2		282	266	249	233	217	201	**1,448**
Present value of social costs of the policy (at 3.5%)								
Firm 1	**1,328**							
Firm 2	**1,295**							

Note: In this example, the invested CAPEX is recovered from consumers on the basis of a straight-line depreciation over 6 years; the compensation for the cost of capital is based on the amount of CAPEX employed in the business (total invested less total recovered) and the cost of capital estimate (post-tax WACC of 12.1% and 9.2%). In this example, OPEX is treated as a pass-through and, thus, OPEX compensation is zero for each year.
Source: Oxera.

In this example, although the first firm is able to deliver the same environmental output at a lower expected CAPEX and OPEX than the second firm (1,060 versus 1,110, £'000), it has a higher cost of capital and thus requires a higher compensation for risks (424 versus 338, £'000). Because of the higher cost of capital, the resulting total social costs of the same environmental outcome are higher for the first firm than for the second firm.

The relationship between CAPEX and OPEX, the cost of capital and the present value of social costs of the environmental outcome shown in this example is illustrative. It is equally possible that the dynamics would be different and that a firm with a higher cost of capital and greater cost efficiency would be considered the most cost-efficient option.

The example models the social costs of the environmental outcome, which are measured as the 'fair' value of the costs that the firms, asked to deliver the output, would need to recover from consumers. The ability of firms to recover the estimated amounts, which would be affected by a number of factors, including the degree of competitiveness of product markets and price elasticity of demand, is not assessed in this report.

Table 4.4 shows the estimates of how much the two firms considered in the example would need to increase their revenues in order to recover the fair value of the costs of the required environmental outcome estimated above in Table 4.3.

Table 4.4 Stylised example of the calculation of the increase in revenues to recover the costs of the environmental outcome (£'000)

Year	Today	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Required increase in revenues to recover CAPEX and OPEX associated with the project[1]								
Firm 1		298	278	257	237	217	197	**1,484**
Firm 2		282	266	249	233	217	201	**1,464**
Required increase in revenues to recover additional corporation tax[2]								
Firm 1		47	39	31	24	16	8	**165**
Firm 2		38	31	25	19	13	6	**131**
Total required increase in revenues								
Firm 1		345	317	289	261	233	205	**1,648**
Firm 2		319	297	274	252	230	207	**1,580**
Assumed revenues before the project was commissioned								
Firm 1		4,000	4,000	4,000	4,000	4,000	4,000	**24,000**
Firm 2		8,000	8,000	8,000	8,000	8,000	8,000	**48,000**
Required increase in revenues as % of revenues existing before the project								
Firm 1		8.6%	7.9%	7.2%	6.5%	5.8%	5.1%	**6.9%**
Firm 2		4.0%	3.7%	3.4%	3.2%	2.9%	2.6%	**3.3%**

Note: [1] Estimated as the sum of 'OPEX recovery' and 'Total CAPEX' (Table 4.3). [2] Estimated as CAPEX-related compensation (Table 4.3) multiplied by (the tax wedge – 1); the tax wedge is estimated as 1/(1 – 28%).
Source: Oxera.

The impact of delaying the policy implementation is discussed next. In order to assess this, the 'delay' scenario is compared with the 'today' scenario. It is assumed that the 'delay' scenario is characterised by the following:

– in order to deliver the environmental output, the second firm (the most cost-efficient option according to the example above) is required to invest the same amount, and has the same cost of capital and the same CAPEX recovery profile as in the 'today' scenario;

– instead of investing 'today' as modelled above, in the 'delay' scenario the second firm is required to invest in six years' time.

The impact on consumers and the investing firm of delaying the investment is assessed below.

The impact on consumers
In the 'delay' scenario, it is assumed that the firm would be required to invest the same amount to deliver the environmental outcome, have the same CAPEX recovery profile, and require the same compensation for risks (because the cost of capital is assumed to remain unchanged). For this reason, the total fair compensation that consumers would have to pay would be same as in the 'today' scenario. However, because the investment would take place after six years and because consumers would start paying the compensation in six years' time, the present value of this policy would be lower.

To estimate the present value of the policy in the 'delay' scenario, if the second firm invests, the estimate of the present value of social costs obtained in Table 4.3 (1,295, £'000) would need to be discounted over six years at the social time preference rate of 3.5%. The resulting estimate of the policy costs would be £1,053 (£'000).

The impact on the firm
As discussed above, the firm would be required to invest the same amount under the same conditions (ie, the same cost of capital and CAPEX recovery profile). For this reason, the fair compensation that the firm would need to recover from consumers would be the same.

Furthermore, if it is assumed that the size of the firm does not increase over time, the relative size of the investment required to deliver the environmental outcome compared with the size of the firm is unlikely to change (measured, for example, as the ratio of the additional revenue required to recover additional costs and the revenue existing before the project, as shown in Table 4.4). Thus, it is unlikely that the delay of the project on its own would make it more affordable for the firm required to implement it.

Although this report assumes full cost recovery by firms required to deliver the environmental outcome, on average firms might not recover their full costs. For this reason, firms might wish to delay the implementation of policy projects under the WFD. As discussed above, the ability of firms to recover costs is not assessed in this report explicitly.

A1 International evidence

Table A1.1 Overview of the cost of capital estimates and asset betas (USA)

Industry	Number of firms	WACC (%)	Asset beta
Apparel	64	8.01	0.82
Auto & Truck	31	6.36	0.57
Bank	550	5.35	0.38
Beverage	48	6.07	0.58
Building Materials	47	7.81	0.73
Cement & Aggregates	13	8.29	0.80
Chemical	154	7.73	0.80
Coal	16	10.92	1.51
Diversified Co.	134	7.12	0.71
Entertainment	101	8.97	1.03
Environmental	96	6.10	0.59
Financial Services	269	5.84	0.38
Food Processing	123	6.39	0.59
Grocery	19	7.65	0.74
Industrial Services	230	7.78	0.84
Machinery	139	7.57	0.77
Maritime	46	5.40	0.54
Paper/Forest Products	42	5.86	0.54
Power	41	13.23	2.03
Railroad	20	7.59	0.74
Recreation	84	8.42	0.93
Trucking	38	8.01	0.70
Water Utility	16	6.46	0.49
Total US market	**7,661**	**7.89**	**0.87**

Note: Unweighted averages of costs of capital for individual firms are shown as the costs of capital for sectors.
Source: Value line as reported by Professor A. Damodaran in 'Damodaran Online' (available at http://pages.stern.nyu.edu/~adamodar/).

Table A1.2 Overview of the cost of capital estimates and asset betas (New Zealand)

Company	Number of firms	WACC	Asset beta
Agriculture	4	8.8	0.53
Building Materials & Construction	3	9.4	0.62
Consumer	11	8.7	0.47
Energy	6	8.7	0.53
Forestry & Forest Products	3	11.3	0.82
Intermediate & Durables	5	11.7	0.92
Investment	3	15.3	1.40
Leisure & Tourism	3	10.4	0.73
Media & Telecommunications	4	13.9	1.20
Mining	1	10.7	0.82
Ports	6	7.9	0.42
Property	9	7.9	0.38
Finance & Other Services	5	9.5	0.60
Textiles & Apparel	2	9.0	0.55
Transport	4	10.7	0.76
Overseas	3	8.8	0.53

Source: PricewaterhouseCoopers (2006), 'The cost of capital report', and Oxera analysis.

Table A1.3 Overview of asset beta estimates (EU countries)

Industry	Number of firms	Asset beta
Agricultural Biotech	3	1.16
Agricultural Chemicals	6	1.17
Agricultural Operations	26	0.41
Airlines	19	0.61
Airport Develop/Maintenance	8	0.61
Alternative Waste Tech	2	1.25
Beverages and Brewery[1]	62	0.38
Building and Construction[1]	196	0.77
Chemicals[1]	66	0.69
Coal	5	0.55
Finance[1]	313	0.58
Electrical[1]	146	0.75
Energy—Alternate Sources	33	1.23
Fisheries	15	0.88
Food—Baking	6	0.42
Food—Canned	2	0.10
Food—Confectionery	9	0.51
Food—Dairy Products	16	0.49
Food—Flour & Grain	7	0.27

Industry	Number of firms	Asset beta
Food—Meat Products	10	0.34
Food—Misc/Diversified	47	0.67
Food—Retail	20	0.50
Forestry	5	0.38
Gas—Distribution	11	0.76
Gas—Transportation	2	0.54
Hazardous Waste Disposal	2	0.41
Life/Health Insurance	25	0.90
Farm Machinery	4	0.27
Marine Services	7	0.72
Mining Services	1	1.22
Oil and Gas Wholesale and Retail[1]	150	1.37
Paper & Related Products	37	0.65
Pollution Control	2	0.35
Poultry	2	0.70
Quarrying	4	0.56
Real Estate Mgmnt/Servic	121	0.40
Real Estate Oper/Develop	103	0.55
Recreational Centres	3	0.60
Resorts/Theme Parks	8	0.58
Shipbuilding	8	0.70
Transport—Air Freight	1	0.34
Transport—Equipment & Leasing	1	0.06
Transport—Marine	63	0.69
Transport other	46	0.28
Travel Services	8	0.68

Note: [1] Unweighted average of costs of capital for sub-sectors.
Source: Datastream as reported by Professor A. Damodaran in 'Damodaran Online' (–available at http://pages.stern.nyu.edu/~adamodar/)

A2 UK industry estimates

Table A2.1 Overview of Risk Management Service estimates of equity betas (UK)

Name	Beta
Resources	0.876
Mining	1.15
Oil & Gas	0.808
Basic Industries	1.038
Chemicals	1.026
Construction & Building Mats	0.962
Forestry & Paper	1.006
General Industrials	1.326
Engineering & Machinery	1.232
Alcoholic Beverages	0.454
Food Producers & Processors	0.614
Leisure Entertain & Hotels	0.916
Transport	0.978
Utilities	0.498
Electricity	0.504
Utilities, Other	0.576
Financials	1.248
Banks	1.186
Insurance	1.252
Life Assurance	1.51
Investment Companies	1.294
Real Estate	0.75
FTSE All Share	1
FTSE 100	0.98
FTSE 250	1.114
FTSE 350	0.998
FTSE Small Cap	1.138

Note: These use FTSE Actuaries Indices. They are portfolio characteristics rather than averages of underlying firm-level betas.
Source: LBS Risk Measurement Service.

A3 Illustrative characteristics of selected UK sectors

Table A3.1 Size of agricultural holdings in the UK

Total area on holdings	Number of holdings ('000)	Hectares ('000)	Number of holdings as % of total holdings
<20 hectares	45	222	58
20–49 hectares	12	399	16
50–99 hectares	9	662	12
100+ hectares	10	3,017	14
Total	**77**	**4,300**	**100**

Source: Defra, Scottish Executive Environment and Rural Affairs Department, Department of Agriculture and Rural Development (Northern Ireland), Welsh Assembly Government, The Department of Environment, Planning and Countryside (2005), 'Agriculture in the United Kingdom 2005'.

Table A3.2 UK ports by tonnage

Tonnage ('000 tonnes)	Number of ports	As a % of total number of ports
500 or less	27	31
1,000	16	18
1,500	5	6
2,000	4	5
2,500	5	6
3,000	1	1
5,000	10	11
10,000	4	5
More than 10,000	16	18

Source: Department for Transport (2006), 'Transport statistics report: Maritime statistics 2005'.

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