Cost of capital

Introduction

1. The cost of capital is defined as the opportunity cost of funds for a company; it is the expected return that is forgone by investing in the company rather than in comparable securities. For our purposes we use the average cost of capital rather than the marginal rate of capital. The weighted average cost of capital (WACC) is a weighted average of the cost of its component parts: debt and equity.[1] In order to assess historical earnings before tax the WACC is expressed in pre-tax nominal terms.

2. There are several techniques for assessing a company's cost of equity, but in practice the most widely used technique by both the CC and other regulators has been the Capital Asset Pricing Model (CAPM).

3. The company cost of capital is the expected return for the company's portfolio of businesses, and if the company's different businesses have different risks they will require different returns. Thus, it is necessary to estimate the cost of capital for the specific business segment which is being reviewed; in this inquiry the domestic bulk LPG business. However, in order to do this it would be necessary to identify a pure-play supplier of domestic bulk LPG. We are not aware that such a company exists and have therefore estimated the cost of capital for LPG operations as a whole. For this to be valid, the assumption that the systematic risk of the supply of bulk LPG to domestic customers is not significantly different to the risk of LPG as a whole needs to hold true.

[1]This is a simplification, and in this simple model all equity risk resides with the equity holders. There is the possibility of various hybrid methods of financing.

4. Given that domestic bulk LPG is mostly used for 'essential' purposes, such as heating and cooking, we considered that it was likely to have less covariance of demand with cyclical factors and risks than non-domestic LPG sectors and the economy generally. It is possible that using LPG operations as a whole might overstate risk and therefore might overstate the cost of capital.

5. However, some of the major suppliers told us that our approach might understate risk and therefore understate the cost of capital. One major supplier, ([✂]) noted that its domestic bulk LPG revenue was more variable than its other LPG businesses and believed that this was indicative of greater risk. However, we considered that such variability is likely to be reflecting the seasonality of domestic bulk LPG demand and the timing of cold periods within a winter. Another major supplier, ([✂]) noted that 'domestic [bulk] LPG represents a proportion of household expenditure [which was] probably second only to mortgage and loan repayments and must therefore be affected to some extent by these factors'. However, we considered that demand from domestic bulk LPG customers was unlikely to be affected by the economic cycle to a greater extent than demand from commercial and agricultural LPG customers.

6. The cost of capital includes:

(a) Generic components:

(i) the risk free rate (RFR);

(ii) the equity risk premium (ERP);

(iii) taxation;[2] and

(b) Industry, or company specific components:

(i) beta;

(ii) debt premium; and

(iii) gearing.

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[2]Taxation can also be company specific.

Cost of equity

7. The CAPM postulates that the opportunity cost of equity (K_e) is equal to the return on risk free securities (R_f), plus the company's systematic risk (as measured by beta or β) multiplied by the equity risk premium (R_m-R_f):

Equation 1 CAPM

$$K_e = R_f + \beta(R_m - R_f)$$

where $RFR = R_f$ and $ERP = (R_m - R_f)$

8. We discuss estimates for the components of CAPM in paragraphs 9 to 56.

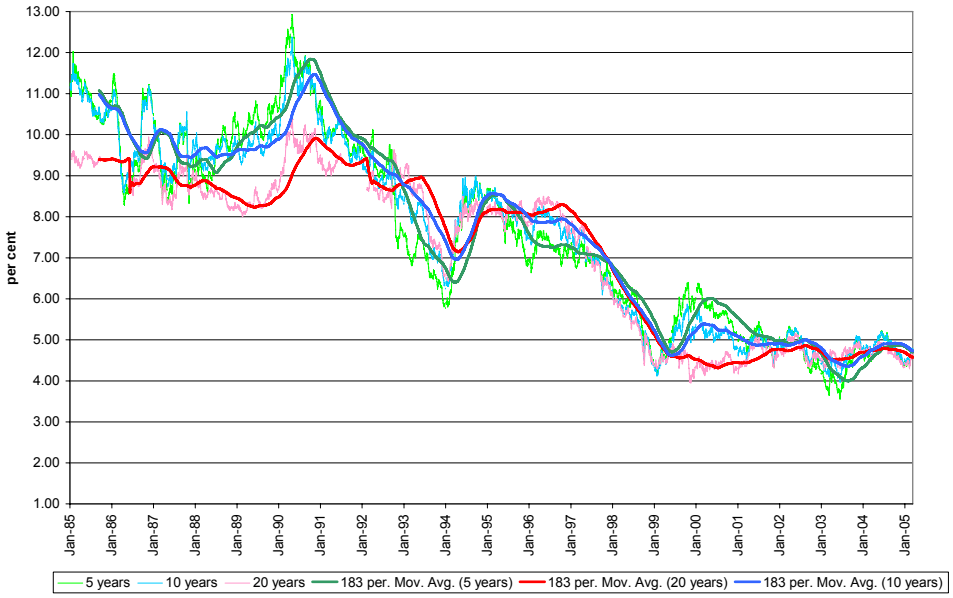
The risk free rate

9. Unlike other elements of CAPM, the RFR is observable from the trading in liquid markets. The UK government has issued index-linked gilts, which are generally considered to have negligible default risk and inflation risk (when measured by the RPI).[3] The redemption yield on these index-linked gilts provides a direct estimate of the real RFR for different maturities. The Bank of England makes regular estimates of such rates over the whole yield curve. In addition, this is adjusted to a zero coupon basis,[4] which helps to deal with tax complications.

[3]Some inflation risk arises from the RPI being lagged by eight months.
[4]A zero coupon security is one that pays no interest and income earned is not subject to capital gains tax.

FIGURE 1

Nominal spot rates



Source: Bank of England.

10. Figure 1 shows that since January 2000 nominal spot yields have generally been in the range[5] of 3.8 per cent to 6.0 per cent, whilst in the period of 1985 to 1999 yields were generally in the range of 4.7 per cent to 12.4 per cent.[6]

11. The OXERA Energy Networks Association Cost of Capital Update paper (1 March 2004) suggests that a range of 2.25 to 2.75 per cent for the real risk-free rate would be appropriate. Assuming inflation of 2.1 per cent,[7] this implies a nominal rate in the range of 4.35 to 4.85 per cent.

12. One major supplier (BP) noted that the RFR has fallen during the period under review, and that it should be higher for the earlier years under review. However, we

[5]Ranges have been calculated as twice the standard deviation less than and greater than the mean.
[6]The 20 years to maturity has shown the greatest range for the 1985 to 1999 period and the five years to maturity has shown the greatest range for the period since 2000, and it is ranges in respect of these data that have been stated.
[7]RPIX for the year ended January 2005 was 2.1 per cent.

concluded that this would be accounted for by using a range of RFRs rather than a single estimate.

13. We concluded that the range of 4.2 to 4.9 per cent for the nominal risk-free rate, was the most appropriate. Several of the major suppliers believed that the RFR was at the upper end of this range.

Equity risk premium

14. The ERP is not directly observable from market data because the future payout from equities, unlike that of bonds, is uncertain. Traditionally the CC and other regulators have used two methods to estimate the ERP: historical data showing the difference between the realized return on equities over the RFR; and forward looking data relating to investors' current expectations of the ERP.

15. If it is assumed that the ERP is constant over time and that, on average, investors' expectations are realized, then current and future ERPs can be estimated from a historical average of the difference between past equity returns and RFRs. Since equity returns tend to be volatile from year to year, it is common practice in the finance literature to consider returns over an extended period.

16. We noted that Fama and French (2002) estimated the ERP in the USA for the period 1872 to 2000 using the dividend growth model and average stock returns to be 3.5 and 5.6 per cent respectively. They argued that the difference between the two estimates was largely due to the unexpected capital gains during the period 1951 to 2000, and accordingly judged that the ERP estimate using the dividend growth model (3.5 per cent) was closer to the true expected value than an estimate using historical returns.

17. Data obtained from Dimson, Marsh and Staunton (2002) has produced arithmetic averages of ten-year holding returns for UK equities for the period 1900 to 2000 of 6.1 per cent. The arithmetic average of ten-year holding returns on UK bonds over the same period was 1.4 per cent.[8] This suggests a historical risk premium of 4.7 per cent. Dimson, Marsh and Staunton (2005)[9] updated data for the period 1900 to 2004 suggested, for the UK, an arithmetic average equity risk premium relative to bonds of 5.2 per cent.

18. Wright, Mason and Miles (2003) estimated the ERP, based upon a set on international data, was in the region of 4 to 5 per cent using an arithmetic mean.

19. We noted that Dimson et al (2002) did not expect stock market investors to enjoy a repeat of the returns of the late 1990s. In terms of excess returns on equities relative to less risky government bills or bonds, their analysis suggests that investors should expect long-run out performance by equities closer to 3 per cent a year on average in future.

20. The more recent OXERA (2004) paper notes that Dimson, Marsh and Staunton (2003) suggested that a higher forward looking UK premia may be appropriate. Dimson et al (2003) estimated a geometric average of 3.9 per cent (an arithmetic average of 5.9 per cent). The OXERA (2004) paper concluded that a range of 3 to 5 per cent was appropriate.[10]

21. Dimson et al (2005) estimated that a forward-looking equity risk premium for the world's major markets would be in the order of 5 per cent relative to government bills

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[8]We considered that the arithmetic mean was more generally used, rather than the geometric mean.
[9]Dimson E, Marsh P, and Staunton M, 2005, *Global Investment Returns Yearbook 2005*, ABN AMRO and London Business School.
[10]The OXERA (2004) paper also used the Dividend Valuation Model (DVM) to estimate the return on equity and therefore the ERP. Using FTSE All share, FTSE 100 and FTSE 30 and assuming a RFR of 1.88, OXERA estimates ERP ranges of 3.43 to 3.68 per cent, 3.55 to 3.80 per cent and 4.00 to 4.25 per cent respectively, with an average range of 3.66 to 3.91 per cent.

on an arithmetic mean basis. Given the risk premium of bonds relative to bills of approximately 1 per cent, the corresponding equity risk premium relative to bonds would be closer to 4 per cent.

22. We also considered the ERP derived from assumptions on long-run nominal returns on equities for pension schemes in major suppliers' groups' annual reports. Both BP's group (BP plc[11]) and Flogas' group (DCC plc[12]) assumed a nominal return on equities of 7.50 per cent, from which we subtracted the nominal RFR (4.5 per cent) and estimated the ERP to be 3.0 per cent.

23. [✂] argued that the ERP was in the region of 4 to 5 per cent. [✂] argued that evidence from Australia and the USA, suggested the ERP was in the region of 4 to 6 per cent. We noted from Dimson et al (2005) that their estimate for the UK ERP is lower than that for both the USA and Australia.

24. From the evidence presented in paragraphs 14 to 23 we considered that there remains much uncertainty about the ERP and we attached weight to both the historical evidence and the evidence of market expectations. Despite the uncertainty, it is necessary to choose an ERP in order to estimate the cost of equity using CAPM. We concluded that a range of 3 to 5 per cent for the ERP was appropriate.

Beta

25. In CAPM, the beta coefficient (β) is taken as a measure of the market (or non-diversifiable) risk of a particular security. The beta coefficient links the return on the

[11]Annual report year ended December 2004.
[12]Annual report year ended March 2004.

security and the average market return.[13] The average market risk of all securities is where β = 1. Stocks with a beta of greater than one amplify the overall movements of the market and are, therefore, more risky than the market. Stocks with a beta of between zero and one also move in the same direction as the market but to a lesser extent and are, therefore, less risky than the market. .

26. The cost of equity is also dependent on the level of gearing; a highly geared company will face greater financial risks than a company with a low level of gearing. This is reflected in the equity beta of the company.

27. The analysis reviewed various equity betas:

(a) the betas of the major suppliers' groups;

(b) historical beta for Calor Group plc;

(c) interpolating DCC plc's[14] LPG beta from its Group beta and its portfolio of businesses ; and

(d) UK companies with a potentially similar risk profile to LPG.

28. Historical estimates of the equity betas (or geared betas) for all the group operations in the suppliers' group companies can be estimated using movements in the group companies' share prices relative to the stock market. Such data are available for publicly-listed companies such as BP plc, Royal Dutch Shell plc (Shell's ultimate parent company) and DCC, but not for SHV Holdings NV (SHV) (Calor's ultimate parent company), which is privately owned. The following table sets out recent equity betas for BP plc, Royal Dutch Shell and DCC.

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[13] $$\beta = \frac{Cov\ (R_e, R_m)}{Var\ (R_m)}$$

[14] DCC plc (DCC) is the ultimate parent company of Flogas and is listed on the Dublin and London stock exchanges.

TABLE 1 **BP plc, Royal Dutch Shell and DCC equity betas**

		BP	*Shell*	*DCC*
1999		0.77	1.03	1.10
2000		0.89	1.13	0.99
2001		0.89	1.10	0.95
2002		0.83	1.06	0.96
2003		0.85	1.02	0.92
2004		0.85	0.97	0.81
2005	1st qtr	0.82	0.95	0.83
5 yrs ended 2004		0.86	1.06	0.93

Source: LBS quarterly Risk Management reports.

29. Amongst other things an equity beta will reflect a company's gearing and the systematic risk of its various activities. In particular, for BP plc and Royal Dutch Shell, LPG revenue was immaterial compared to total group revenue ([✂]), whilst DCC also had significant non-LPG operations such as IT distribution. The betas stated in Table 1 therefore also reflect these other activities. Theoretically, DCC group beta is the average of the beta of its various businesses weighted by the market value of those businesses.

30. The following table sets out DCC businesses.

TABLE 2 **DCC businesses and possible equity betas**

DCC business	*Business PBIT as % of total PBIT*	*Proxy FTSE sector*	*Recent equity beta of sector*
IT Distribution	26	Support services—delivery services	0.88
Healthcare	11	Medical equipment and supplies	0.77
Food & Beverage	9	Beverages—soft drinks	0.51
Environmental	4	Support services—environmental control	0.88
Other	12	Business support services	0.94
Sub-total (excl energy)	62		0.82
Energy (LPG and oil)	38	Implied (balancing figure)	**0.85**
Total	100		0.83

Source: DCC annual report 2004 and LBS quarterly Risk Management report.

Notes:
1. PBIT figures are for the year ended 31 March 2004.
2. Recent beta relates to the period January to March 2005.

31. In the absence of a better proxy, the relative profit before interest and tax is used as an estimate for the relative market capitalization of the various businesses. We noted that this may not be an accurate method.

32. We noted that the equity betas of the FTSE sectors will reflect the gearing of those sectors, whilst DCC's equity beta reflects its gearing.

33. The analysis suggests that DCC's energy business has an equity beta of 0.85.

34. Furthermore, such analysis is subjective as it is dependent on the sectors chosen as best fit and the time period chosen. We also noted that DCC energy includes oil distribution.

35. However, using an average for the five years ended 2004 and assuming all non-energy is in the 'Business Support Services' sector the estimated DCC energy equity beta of 0.83 is very similar to that in Table 4.[15]

36. Prior to 1997 Calor Gas was listed on the London Stock Exchange; as part of the acquisition by SHV in early 1997 Calor Group PLC was re-registered as a private company and de-listed. We analysed the pre-1997 period as an example of a 'pure play'[16] LPG supplier in the UK. Our analysis, using monthly data from May 1987 to December 1996,[17] was based on CAPM (ie a one factor model) and Fama and French (a three factor model). We concluded from our analysis that:

(a) Calor's equity beta for the period was estimated to be 0.8;[18] and

(b) the small company premium was not statistically significant.[19]

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[15]DCC five-year average beta is 0.93. Business services five-year average beta is 0.99. If Business Support Services represents 62 per cent of DCC business the implied energy beta is 0.83.
[16]A pure play company has only one class of business; in this case LPG.
[17]By using the conventional 60-period (five-year) rolling averages this period was reduced to May 1992 to December 1996.
[18]The 95 per cent confidence interval was 0.56 to 1.04.

37. We reviewed the equity betas for three US pure play LPG suppliers (Suburban Propane Partners LP, Ferrellgas Partners LP and AmeriGas Partners LP), which were in the region of 0 to 0.2 and therefore significantly lower than all other estimates. In particular, we noted that the betas were less than UK utility betas. We concluded that, without further and extensive research to understand the US LPG market and safety regime, it would be inappropriate to rely upon such analysis.

38. Other companies, which are not in the reference market but in a similar business, or in a business that faces a similar risk, may be used as a guide to an LPG equity beta. Possible guides could come from the utilities sector, including suppliers of energy. However, we noted that whilst LPG was used for the same purpose as natural gas or electricity, both the regulatory environment (including price setting) and the way in which the product is delivered were fundamentally different. Therefore, although utilities are not a wholly appropriate proxy, they did present a framework in which to consider the LPG beta.

TABLE 3 **Utility equity betas**

Industry	*Industry average recent equity beta*	*Number of companies*	*Equity beta range*	
Gas distribution	0.85	2	0.46	0.86
Electricity	0.47	8	0.15	1.45
Water	0.50	10	0.36	0.97
Multi-utilities	0.64	1	N/A	N/A

Source: LBS Risk Management Report (Jan–Mar 2005).

Notes:
1. Recent means January to March 2005.
2. Average company betas weighted by market capitalization.
3. N/A = not applicable.

39. This analysis suggested that, in general, average utility equity betas were in the region of 0.5 to 0.9.

[19]Neither the factor loading on the small company premium nor the factor loading of the 'value minus growth' were statistically significant.

Major suppliers' views on beta

40. We were told that, typically, [✂] would use an equity beta around [✂], and it believed that, [✂].

41. For the purpose of this inquiry, [✂] estimated that its equity beta was in the range of [✂] to [✂], (and its asset beta of [✂] to [✂]). It suggested possible comparators including BT Group plc (BT) with an equity beta of 1.3 (asset beta of 0.89) and for an Independent Gas Transporter (IGT). [✂] noted that an Ofgem paper[20] estimated equity betas for an IGT in the range of 0.7 to 1.0 (asset beta 0.46 to 0.66). [✂] believed that they were good comparators because these had similar levels of demand volatility and similar asset intensive business model.

42. Flogas noted that DCC's equity beta (from Bloomberg) was 0.52 for 2003/4 [✂]. Flogas also cited an ABN Amro report of 9 July 2003 called 'Valuation and the cost of capital' which estimated the equity beta of gas distributors to be 0.6.

43. Shell told us that its group's equity beta was [✂]. Shell noted that domestic bulk LPG supply involves an upfront investment to acquire a customer, followed by a period during which the firm attempts to recoup the investment from a per unit price. It stated that this was similar to mobile phone or pay-TV, and cited examples of O_2 (equity beta 0.74), Vodafone (1.00), France Telecom (Orange) (1.20), NTL (1.15) and Sky (1.33). We concluded that these analogies were less appropriate than our reference to the utility sector because customers may not consider them as essential, and therefore such products are likely to show greater covariance with cyclical economic factors.

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[20] *Independent Gas Transporter Charges and Cost of Capital*, Consultation Paper, Ofgem, February 2003.

44. Shell told us that there were several factors which could affect the reliability of our estimate of Calor's historical beta. Firstly, the structure of the market was different when Calor was listed compared to now. Secondly, Calor's operations were not limited to UK LPG ([✂]). Thirdly, SHV had a significant shareholding and this may have distorted the market for Calor's shares. Nevertheless, we felt that this was a valuable addition to our dataset.

45. Table 4 summarizes the various estimates of an equity beta for LPG. Using gearing based on book values,[21] the equivalent asset betas are also stated. Asset betas are estimated from equity betas using Equation 2 set out below, except those provided by one major supplier who used the Miller equation[22] to calculate the asset betas from the equity betas.

[21]Gearing used in Table 4 is based upon the information supplied by the major suppliers (see Table 5), and publicly available information sourced by the CC.

[22] $\beta_g = \beta_u \left\{1 + \frac{D}{E}\right\}$

TABLE 4 **Summary of betas using book value gearing**

	Equity beta	*Gearing %*	*Asset beta*
CC analysis			
Calor—Historical	0.80	[✂]	[✂]
DCC energy sector	0.83	35	0.60
BP plc	[✂]	[✂]	[✂]
DCC plc	0.93	35	0.68
Shell plc	1.06	15	0.94
UK utilities (low beta, low gearing)	0.50	50	0.29
UK utilities (low beta, high gearing)	0.50	58	0.25
UK utilities (high beta, low gearing)	0.90	50	0.53
UK utilities (high beta, high gearing)	0.90	58	0.46
Submissions by the major suppliers			
Calor (low beta)	[✂]		
Calor (high beta)			
BP			
Flogas (low beta) using Miller equation			
Flogas (high beta) using Miller equation			
Shell			
Proxies suggested by the major suppliers			
IGT (low beta)	0.70	38	0.49
IGT (high beta)	1.00	38	0.70
BT	1.30	35	0.94
O_2	0.74	12	0.68
Vodafone	1.00	11	0.92
France Telecom (Orange)	1.20	75	0.39
Ofgem price determination	1.00	58	0.51
Ofwat price determination	1.00	50	0.59

Source: CC analysis and major suppliers' submissions.

46. The following equation sets out the relationship between the equity and asset beta.

Equation 2 The relationship between the equity and asset betas (Modigliani and Miller equation)

$$\beta_g = \beta_u + \beta_u \frac{D}{E}(1-t)$$

47. One major supplier (Flogas) told us that in light of the precedent from almost all the UK regulators, and given the concerns about differential approaches across regulated sectors leading to investment distortions, there is a case for placing some weight on the Miller equation and that it should not be disregarded completely. The major supplier also noted that the Miller equation is a more conservative approach to setting the cost of capital, and to disregard it would require the tax position of the marginal investor to be analysed. We noted that the Miller equation assumes that no additional tax is payable by individuals on equity returns and that the corporate tax

rate and the individual tax rate on debt returns are equal. However, we concluded that Equation 2 was the most appropriate given the current taxation regime in the UK.

48. We have taken a variety of approaches to estimating the beta. Individually, each method may have limitations, biases and/or inaccuracies. However, by basing a conclusion on a range of estimates we believed that the impact on our conclusion of inaccuracies in individual estimates was minimized. On the basis of the information in Table 4, we concluded that the most appropriate asset beta for LPG was in the range 0.6 to 0.8.

Gearing

49. Gearing, used to weight the various components of the WACC, can be based on the following:

(a) actual book values of debt and equity;

(b) actual market values of debt and equity; or

(c) target gearing.

50. Gearing is important for three reasons:

(a) to weight the various costs of capital in the WACC;

(b) to adjust the equity betas of comparator companies to the gearing of the LPG businesses; and

(c) it affects the debt premium.

51. Ideally gearing should be calculated using market values of both equity and debt. Where this is not available book values are used. The following table summarizes the submissions by the major suppliers and CC calculations.

TABLE 5 **Gearing—D/(D+E) for latest period available**

Valuation method of equity: *Valuation method of debt:*	*Market value of equity Book value of debt* *%*	*Book value of equity Book value of debt* *%*
Supplied by the major suppliers		
Calor		[✂]
BP Group		
Flogas		
DCC		
Comparators suggested by the major suppliers		
IGT		38
BT		35
Analysis by CC based on publicly available information		
SHV		33
BP Group	16	24
Shell Group	12	15
DCC	15	35

Source: Responses to the Financial Questionnaire and CC analysis.

52. Gearing of the LPG companies (BP LPG UK Ltd, Shell Gas Ltd, Calor Gas Ltd and Flogas UK Ltd), is of limited use as it reflects intragroup financing and not a stand-alone capital structure.

53. Flogas told us that its gearing was [✂] per cent; [✂].

54. Calor estimated gearing based on what it considered to be appropriate methods of financing the assets of its domestic bulk LPG business and concluded on [✂] per cent. Calor believed [✂] per cent to be too high; however, we considered that, due to the interdependencies between gearing and other components of WACC, our conclusions were not particularly sensitive to the gearing assumption.[23]

55. The OXERA (2004) report noted that 'there is no consistent academic evidence, or normative model, that predicts unequivocally what an optimal capital structure might

[23]For example, moving from [✂] per cent to [✂] per cent gearing reduces the high end of the range of WACC by less than 0.5 per cent from [✂] per cent to [✂] per cent.

be'. The report goes on to add that 'considering a wide range of national and international evidence gearing [for Energy Network Associations] of 50 per cent may be close to the norm'. However, the CC has tended to place more weight on the major suppliers to an inquiry's actual gearing.

56. We concluded that a range of gearing between 30 to 50 per cent would be appropriate.

Cost of debt

Debt premium

57. The cost of debt (K_d) consists of the RFR plus the debt premium for a particular maturity. The debt premium reflects the premium on corporate debt over the equivalent gilts to allow for greater risk of default on corporate debt. It is by definition a premium over the RFR and has been typically estimated using comparisons between yield on corporate debt and those on gilts.

58. We noted the Standard and Poor's credit rating for the corporate debt of BP plc and Royal Dutch Shell was AA+ and AA respectively. DCC and SHV did not have a Standard & Poor's credit rating. It would not be appropriate to use the BP plc and Royal Dutch Shell credit ratings as these reflected the size and scope of their whole business of which LPG comprised a very small element.

59. The UK utility sector showed a strong tendency to 'A' ratings.[24] The current yield spread is summarized in Table 6.

[24]At 5 April 2005 of the 65 S&P ratings in the UK utility sector 42 (or 65 per cent) were of 'A' rating. (AAA:0, AA:6, A:42, BBB:14, BB:3, B or less:0).

TABLE 6 **Debt premium spreads over RFR**

	Spread			
	AAA	*AA*	*A*	*BBB*
1999	1.00	1.30	1.58	2.49
2000	1.30	1.53	2.01	2.34
2001	0.95	1.23	1.81	2.17
2002	0.74	0.98	1.42	2.25
2003	0.59	0.74	0.94	1.64
2004	0.62	0.70	0.87	1.29
5-year average ended 2004	0.84	1.04	1.41	1.94

Source: Thomson Datastream.

60. The debt premium for all ratings has decreased in recent years. We noted that most utilities have an A rating with a range of 0.90 to 2.00 and an average of 1.40. However, [✂] told us that they believed LPG debt premiums would be higher than that of a utility because LPG cashflows are inherently more risky.

61. [✂] told us that a [✂] rating and therefore a debt premium of 1.50 to 2.00 per cent would be appropriate. [✂] told us that it believed a debt premium of [✂] to [✂] per cent was appropriate given its cost of debt and [✂] ratings.

62. We concluded that a debt premium of 1.50 to 2.00 per cent was appropriate. We noted the relationship between gearing and the debt premium, and concluded that the low end of the gearing range (30 per cent) is consistent with the low end of the debt premium range (1.5 per cent) and that the high end of the gearing range (50 per cent) is consistent with the high end of the debt premium range (2.0 per cent).

Small company premium

63. [✂] told us that it thought a small company premium, to be added to the WACC, of 0.50 per cent was appropriate. However, we concluded that this was not appropriate for the following reasons.

(a) In respect of the cost of equity, our Fama and French analysis of Calor's returns when listed, suggested that a small company premium was not statistically significant.

(b) In respect of cost of debt, any small company premium is included in the debt premium. [✂] initially told us that a debt premium should be 1.00 to 1.50 plus a small company premium of 0.5 per cent. In paragraph 62 we concluded that a debt premium of 1.50 to 2.00 per cent was appropriate.

WACC

64. We took the approach of estimating a single range of WACCs to cover the whole period of financial performance reviewed in Appendix J. By estimating a range of WACCs we have taken into account the possibility of minor variations year on year.

65. BP told us that our WACC estimations concentrated on the period of 2002 onwards and that this understated the WACC for the period prior to 2002. In particular, BP believed we had underestimated the ERP and the RFR for the earlier periods. However, we noted that in the CC's three inquiries in 2000[25] it used an ERP of 4 per cent, and this was in the middle of the range we used for this inquiry. We also noted that the CC used a real RFR of 3 per cent (approximately 5 per cent nominal RFR) in two of those inquiries and a nominal RFR of 4.6 per cent in the other. We noted that the nominal ERPs (4 per cent) were within the range we used in this inquiry (3 to 5 per cent), and that one of the nominal RFR (4.6 per cent) was within the range and two nominal RFRs (5 per cent) were only slightly above the range we used in this inquiry (4.2 to 4.9 per cent).

66. The WACC is defined as:

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[25]Sutton & East and Surrey Water, Mid Kent Water and Scottish Milk.

Equation 3 WACC

$$WACC = \frac{K_e MV_e + K_d MV_d}{MV_e + MV_d}$$

67. Table 7 sets out the range of WACCs based upon our conclusions on the individual components. The 'low' columns show the low end of the ranges of RFRs, ERPs and asset betas, whilst the 'high' column shows the high end of these ranges. Gearing is shown separately due to the interdependency between it and the equity beta and the debt premium.[26]

68. We noted that gearing of 30 to 50 per cent is based upon book values of equity. The Annex to this Appendix discusses the WACC assuming gearing is based on market values of gearing.

TABLE 7 **Illustrative WACCs using book value gearing**

	Low 30% gearing	*Low 50% gearing*	*High 30% gearing*	*High 50% gearing*
RFR	4.20	4.20	4.90	4.90
ERP	3.00	3.00	5.00	5.00
Asset beta	0.60	0.60	0.80	0.80
Equity beta	**0.78**	**1.02**	**1.04**	**1.36**
Cost of equity (post tax)	6.54	7.26	10.10	11.70
Tax %	30	30	30	30
Cost of equity (pre tax)	**9.34**	**10.37**	**14.43**	**16.71**
Debt premium	1.50	2.00	1.50	2.00
Cost of debt	**5.70**	**6.20**	**6.40**	**6.90**
Gearing %	30	50	30	50
WACC	**8.25**	**8.29**	**12.02**	**11.81**

Source: CC calculations.

69. We concluded that the appropriate range for the WACC was 8.3 per cent to 12.0 per cent with a mid-point of 10.1 per cent.

[26] Increased gearing:
- increases the equity beta and therefore the cost of equity.
- increases the debt premium.
- reduces the weighting of the cost of equity within the WACC.

WACC based on market value gearing

1. We noted that, theoretically, gearing should be based on market values of both debt and equity. For debt, we have assumed that the market and book values are not materially different. Given most debt is not listed, this appears reasonable. Furthermore, as long as the coupon on listed debt is not significantly different to the cost of debt, this assumption does not appear to be unreasonable.

2. For equity, we have based our analysis substantially on book value. We considered that this was an appropriate approach because of the availability of information. In particular:

   - there were more proxies for book value gearing than market values gearing;
   - there were no market valuations of equity for pure play bulk domestic LPG businesses; and
   - there was only one UK example of market valuation for the equity of a pure play LPG supplier (Calor, prior to 1997), and there were reasons why it may not be appropriate. Firstly, SHV was a significant shareholder when Calor was listed therefore it is possible that Calor shares were thinly traded and, as a consequence, the market value of equity may not have been an appropriate proxy. Secondly, during the time when Calor was listed it had no debt. We considered that an efficient capital structure would have included some debt.

3. However, below in Table 1 we show the impact of using market values of equity.

TABLE 1 **Summary of betas using market value gearing**

	Equity beta	*Gearing %*	*Asset beta*
CC analysis			
Calor—Historical	0.80	(✂)	
DCC energy sector	0.83	15	0.74
BP plc	(✂)		
DCC plc	0.93	15	0.83
Shell plc	1.06	12	0.97
Submissions by the major suppliers			
BP Shell	(✂)		
Proxies suggested by the major suppliers			
O_2	0.74	11	0.68
Vodafone	1.00	10	0.93
France Telecom (Orange)	1.20	46	0.75

Source: Equity betas: major suppliers' submissions. Gearing and asset betas: CC analysis.

4. Using gearing based upon market values for equity the asset beta appears to be in the range of 0.7 to 0.9.

5. Gearing based upon market values appears to be in the region of 10 to 20 per cent. However, at such levels of gearing the debt premium is likely to be lower than the 1.5 to 2.0 per cent discussed in paragraph 61.

6. Applying this gearing (10 to 20 per cent) and the asset beta range (0.7 to 0.9) to the other WACC assumptions the following Table 2 suggested the WACC was in the range of 8.9 to 13.2 per cent with a mid-point of 11.0 per cent.

TABLE 2 **Illustrative WACCs using market value gearing**

	Low 10% gearing	*Low 20% gearing*	*High 10% gearing*	*High 20% gearing*
RFR	4.20	4.20	4.90	4.90
ERP	3.00	3.00	5.00	5.00
Asset beta	0.70	0.70	0.90	0.90
Equity beta	**0.75**	**0.82**	**0.97**	**1.06**
Cost of equity (post tax)	6.46	6.67	9.75	10.19
Tax %	30	30	30	30
Cost of equity (pre tax)	**9.23**	**9.53**	**13.93**	**14.55**
Debt premium	1.50	2.00	1.50	2.00
Cost of debt	**5.70**	**6.20**	**6.40**	**6.90**
Gearing %	10	20	10	20
WACC	**8.88**	**8.86**	**13.18**	**13.02**

Source: CC calculations.