Adjusting Heathrow's cost of capital for skewness: Methodological and qualitative issues

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SUMMARY

The upside potential of Heathrow is limited by a capacity constraint, whereas there is significant downside risk. This risk profile gives negative skewness to the potential returns from Heathrow. Negative skewness is viewed by the capital market as an unattractive feature of equity investments, for which the market requires compensation in the form of a higher return. Therefore, the equity market requires a higher expected return to compensate for negative skewness of the returns to BAA. This premium is in addition to the CAPM risk premium, which does not allow for skewness of returns.

Authoritative empirical studies have shown that companies with significant skewness should have an adjustment to their cost of equity measured by the CAPM. The correct measure to use in adjusting the cost of equity is coskewness with the market return, which allows for diversification. The adjustment increases the cost of equity when coskewness is negative and decreases it when coskewness is positive.

This adjustment is consistent with practitioners' views, which indicate that equity is more attractive if it has greater upside and less attractive if it has greater downside. Negative coskewness indicates more downside than upside and is, therefore, consistent with a higher expected return to compensate for this. Positive coskewness indicates more upside than downside and is, therefore, consistent with a lower expected return.

This report focuses exclusively on the effect of skewness on the cost of equity and does not discuss other components of the cost of capital. It focuses only on methodological and qualitative arguments, and on issues of principle which arise in the measurement of the adjustment.

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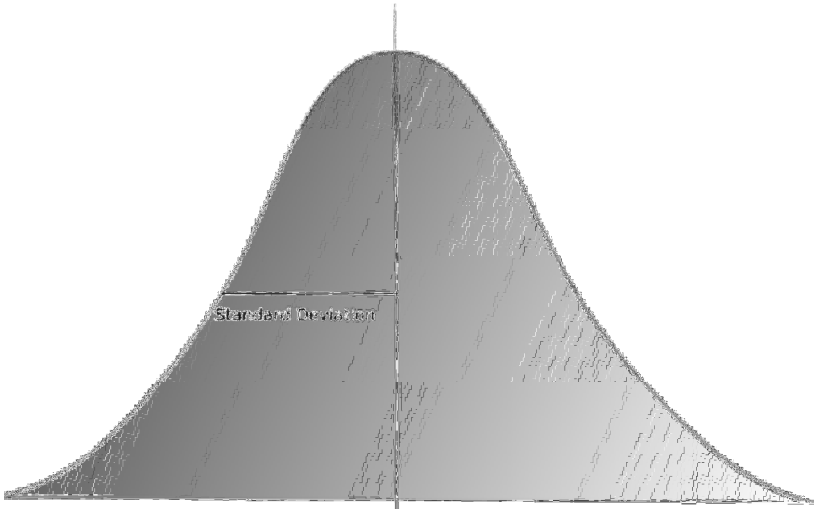
This report concerns the impact of skewness of share returns on the cost of equity. Skewness means that the upside potential of a company's shares is different to their downside risk. Positive skewness means that upside potential is greater than downside risk, and negative skewness means that downside risk is greater than upside potential. Section 1 of the report defines skewness and explains its relevance. Section 2 shows that investors care about skewness, and Section 3 discusses how to measure this with the co-skewness coefficient. Section 4 reviews the magnitude of the co-skewness premium/discount. Section 5 gives a qualitative discussion of why this issue has not been seen as important in other regulated sectors in the UK, and why it has not been a concern of the CAA until Q5/6. Finally, Section 6 discusses the consequences of not taking into account the effect of skewness on the cost of equity of Heathrow.

1. Introduction: Skewness and its relevance to the cost of equity

The capital asset pricing model (CAPM) is commonly used to estimate the cost of equity. The analysis which leads to the CAPM assumes that share returns have normal distributions, as shown in Figure 1. This distribution is symmetric, with equal chances of the same upside gain and downside loss. Because of this symmetry, risk can be fully described by the standard deviation (or equivalently by the variance).

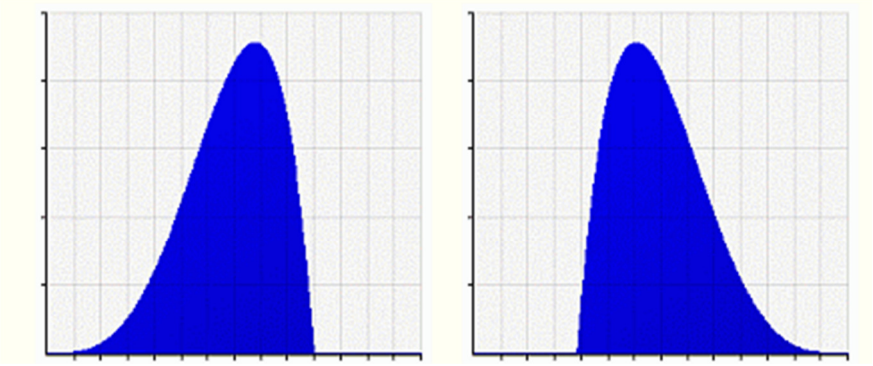
Figure 1: A normal distribution



When returns are not normally distributed, the CAPM is an incomplete model. In particular, when there is significant skewness of returns the standard deviation (and consequently the

CAPM beta) is no longer an adequate description of risk. Figure 2 shows skewed distributions of returns. The left-hand distribution is negatively skewed. This has a limited upside relative to its downside risk. The right-hand distribution is positively skewed. This has a limited downside relative to its upside potential.

Figure 2: Negatively and positively skewed distributions



A normal distribution (and hence the CAPM) is a good approximation for most shares. However, this is not true for all shares. When there is significant skewness empirical evidence indicates that it affects the cost of equity. In the presence of significant skewness the CAPM is an incomplete way of estimating the cost of equity and an adjustment should be made which reflects the impact of skewness on shareholders' required returns. In particular, when a share has limited upside potential but significant downside risk its returns have negative skewness. If this skewness cannot be diversified it will result in negative co-skewness, which will increase the required return on that equity.

A leading practitioner handbook discusses this assumption in the context of an investment in Cisco shares, which in the example is assumed to have an expected return of 30%:

> "*One of the limitations of variance is that it considers all variation from the expected return to be risk. Thus, the potential that you will earn a 60% return on Cisco (30% more than the expected return of 30%) affects the variance exactly as much as the potential that you will earn 0% (30% less than the expected return). In other words, you do not distinguish between downside and upside risk. This is justified by arguing that risk is symmetric – upside risk must inevitably create the potential for downside risk. If you are bothered by this assumption, you could compute a modified version of*

the variance, called the semi-variance, where you consider only the returns that fall below the expected return." (Damodaran (2003))

This author uses variance rather than standard deviation (which is equivalent) as a measure of risk. Consequently he mentions the semi-variance rather than skewness, to which it is closely related.

In summary, skewness measures the relative upside potential and downside risk of an investment. Zero skewness, which is the assumption underlying the CAPM, indicates equal upside and downside. Positive skewness indicates more upside potential than downside risk. Negative skewness indicates more downside risk than upside potential. Skewness matters because it affects the desirability of an investment to investors and, hence, its cost of equity.

2. The impact of skewness on investors

2.1 Investors care about the skewness of returns

Before discussing technical issues, it is important to emphasize the intuition behind the fact that skewness affects the cost of equity. Practitioners do not generally express this idea using the word skewness. However, they consistently emphasise the importance of the upside potential of equity relative to its downside risk, which is the same idea.

Practitioners emphasise the fact that upside potential is what makes equity attractive, whereas downside risk is what makes it unattractive. For instance, the following extract from one of the leading practitioner handbooks on equity valuation makes clear the importance of upside potential in determining equity value and, consequently, the cost of equity:

"*What are the four cornerstones of finance and how do they guide the creation of lasting corporate value? The first and guiding cornerstone is that companies create value by investing capital from investors to generate future cash flows at rates of return exceeding the cost of that capital (that is, the rate investors require to be paid for the use of that capital). The faster companies can grow their revenues and deploy more capital at attractive rates of return, the more value they create. In short, the combination of growth and return on invested capital (ROIC) drives value and value creation.*" (McKinsey (2011) p4)

In other words, the ability to earn significantly more than the cost of capital is "the first and guiding cornerstone" of equity value, according to McKinsey. Equity is expected to have significant upside potential.

The following standard disclaimer from a Nomura Securities' analysts' report also makes clear that the attractiveness or unattractiveness of equity is determined by upside potential relative to downside risk. This statement is typical of analysts:

> "*Stock recommendations are based on absolute valuation upside (downside), which is defined as (Fair Value - Current Price)/Current Price, subject to limited management discretion. In most cases, the Fair Value will equal the analyst's assessment of the current intrinsic fair value of the stock using an appropriate valuation methodology such as Discounted Cash Flow or Multiple analysis etc. However, if the analyst doesn't think the market will revalue the stock over the specified time horizon due to a lack of events or catalysts, then the fair value may differ from the intrinsic fair value. In most cases, therefore, our recommendation is an assessment of the difference between current market price and our estimate of current intrinsic fair value. Recommendations are set with a 6-12 month horizon unless specified otherwise. Accordingly, within this horizon, price volatility may cause the actual upside or downside based on the prevailing market price to differ from the upside or downside implied by the recommendation.*
>
> *• A rating of "1", or "**Strong buy**" recommendation indicates that upside is more than 20%.*
>
> *• A rating of "2", or "**Buy**" recommendation indicates that upside is between 10% and 20%.*
>
> *• A rating of "3", or "**Neutral**" recommendation indicates that upside or downside is less than 10%.*
>
> *• A rating of "4", or "**Reduce**" recommendation indicates that downside is between 10% and 20%.*
>
> *• A rating of "5", or "**Sell**" recommendation indicates that downside is more than 20%.*" Regulatory Disclosure, 4 March 2009, Analyst Report, MTS

As both of these extracts indicate, a share which has upside potential which is limited relative to its downside risk (i.e. negative skewness) is less attractive. This will lead to lower value and, equivalently, a higher cost of equity.

An example of the importance of skewness from a more formal practitioner perspective is given by the leading risk analysis firm Riskmetrics, which emphasises the effect of skewness in the measurement of the risk of portfolios of financial assets (Li (1999)). The same point is made in a study of hedge fund behaviour and performance, which emphasises that mean-variance analysis cannot fully explain the behaviour of this important group of equity investors (Agarwal and Naik (2004)).

The effect of skewness on investor behaviour can also be seen in academic studies of the portfolio choices of investors. Mitton and Vorkink (2007) investigate the portfolios of 60,000 investors and find that "investors sacrifice mean-variance efficiency for higher skewness exposure". In other words, investors treat positive skewness as if it is an attractive feature of equity (and negative skewness as unattractive).

In summary, although they do not generally call it skewness, investors react negatively to limited upside potential relative to downside risk. Their behaviour is consistent with a higher expected return on assets with negative skewness and a lower expected return on assets with positive skewness.[1]

2.2 Setting the cost of equity using the CAPM assumes absence of skewness

The previous Section has shown that investors care about skewness. However, the analysis leading to the CAPM assumes that share returns are normal, which means that skewness is ignored. The following quotation from a leading practitioner handbook makes this point, in its discussion of the basis of the CAPM:

> "*In the special case where the distribution of returns is normal, investors do not have to worry about skewness and kurtosis ….When return distributions take this form, the characteristics of any investment can be measured with two variables – the expected return …. and the standard deviation or variance.*" (Damodaran (2002) p62-64).

The above quotation makes clear that the assumption of a normal distribution, which leads to the CAPM, is a special case. The following quotation from a leading corporate finance textbook makes the stronger assertion that the assumption of a normal distribution applies to all shares:

[1] The effect of skewness can also be seen in the analysis of other financial assets, such as options, which can have extreme levels of skewness. Because of that, these assets are never analysed using the CAPM, in recognition of the fact that the unadjusted CAPM is misleading when applied to assets with skewed returns.

> "*When measured over some fairly short interval the past rates of return on any stock conform fairly closely to a normal distribution*." (Brealey, Myers, and Allen (2008) p 207)

This strong simplifying assumption is used to justify using the CAPM. The reason that Brealey, Myers, and Allen are willing to use the assumption of a normal distribution is that this is a good approximation for most shares (but not for all shares as they assert). As discussed below in Section 4, there is strong evidence that some shares have significant skewness and that this affects their required returns. Thus the issue is how to identify shares which do not have normal distributions of returns and how to adjust their costs of equity for this.

2.3 Skewness is the accepted measure of asymmetric equity returns

The fact that the CAPM does not allow for asymmetric returns raises the issue of how to adjust the analysis when returns are not normal. The same leading practitioner handbook quoted above discusses how to adjust CAPM analysis when distributions are not symmetric:

> "*In the … general case, where distributions are neither symmetric nor normal, it is still conceivable that investors will choose between investments on the basis of only the expected return and the variance, if they possess utility functions that allow them to do so. It is far more likely, however, that they prefer positive skewed distributions to negatively skewed ones, and distributions with a lower likelihood of jumps (lower kurtosis) over those with a higher likelihood of jumps (higher kurtosis). In this world, investors will trade off the good (higher expected returns and positive skewness) against the bad (higher variance and kurtosis) in making investments.*" (Damodaran (2002) p64)

Hence negative skewness is a bad feature of returns which investors will trade off for a higher expected return, and skewness is the appropriate measure of asymmetry.

2.4 There is no argument of principle for ignoring the effect of skewness on the cost of equity. All arguments of principle are in favour of including it.

As shown above, standard cost of equity analysis using the CAPM assumes no material skewness. If there is negative skewness of a material amount this would be viewed as negative by both academics and practitioners and should be compensated with an increased risk premium. However, in practice most estimates of the cost of equity use the CAPM. This

raises the issue of what considerations should affect the choice of whether to make a skewness adjustment to the cost of equity. Discussing this issue, a leading textbook on portfolio analysis says:

> "*Apart from tractability and tradition there are no reasons not to consider third and higher central moments in portfolio problems.*" (Ingersoll (1987) p99).

The third moment referred to here is skewness. As this quotation shows, the issue of whether a skewness adjustment should be included is not one of principle, but rather should be based on practical considerations.

In other words, as a matter of principle skewness does matter in portfolio analysis, does affect expected returns, and should be included in the cost of equity. However, in practice skewness is usually ignored and the cost of equity is estimated using the CAPM. There are three principle reasons for this:

a. For most shares the level of skewness is not material and it is ignored because any adjustment would be insignificant. However, if the effect of skewness can be shown to be material for Heathrow this argument is not relevant.
b. Tractability: There are practical issues involved in estimating the correct adjustment for skewness However, there are also difficulties in measuring the CAPM risk premium, which are of a similar nature to the difficulties of measuring the skewness adjustment, and this does not prevent the CAPM being used.
c. Tradition: It has become conventional to estimate the cost of equity using the unadjusted CAPM.

Reason (c) (i.e. using the unadjusted CAPM as a matter of tradition) may be thought to have a logical basis. In regulation it might be thought of as a way of ensuring consistency between regulators. If most regulators traditionally use the CAPM without a skewness adjustment it might be thought that consistency requires that no skewness adjustment should be made by any other regulator. However, that is not so. If skewness is generally not a material consideration then it is consistent to use the unadjusted CAPM for those cases where this is the case. If, in a particular instance, skewness is material then true consistency requires that the skewness adjustment be included in that instance. Otherwise that regulated entity will be either advantaged or disadvantaged relative to other regulated entities by the exclusion of the skewness adjustment.

In summary, arguments of principle favour including a skewness adjustment if it is of material size. The main obstacle to doing this is estimating the size of the adjustment. This is discussed below in Section 4.

2.5 Summary of Section 2

Investors care about skewness of returns. They view equity as more attractive if it has significant upside potential relative to downside risk. Negative skewness, indicating limited upside relative to downside risk, is a negative feature of equity which increases its required return. Standard estimation of the cost of equity using the CAPM ignores this because it assumes normal distributions of share returns, which have no skewness.

Most shares do not have significant skewness. However, when there is significant skewness in returns the CAPM is not an accurate description of the risk of that investment. In such circumstances an adjustment to the cost of equity estimated by the CAPM is required. While the estimation of the size of this adjustment is an empirical issue, the issue of principle is clear. In the presence of significant skewness the CAPM does not deliver a fair estimate of investors' required cost of equity.

3. The form of the skewness adjustment: Coskewness

3.1 The coskewness coefficient

As with CAPM analysis, there are two levels at which one can think of the effect of skewness: the effect on an investor's entire portfolio and the effect on an individual share. Estimation of the cost of equity requires an approach which can be applied at the level of the individual share. For this, one needs a measure of coskewness which allows for the diversification of risk in portfolios. The measure which does that is the coskewness of a share with the market (defined below). This plays the same role in adjusting the cost of equity for skewness as the beta does in the CAPM. Just as beta is a measure of comovement with the market which allows for portfolio diversification, so coskewness is the appropriate measure of skewness to allow for the same thing.

The extended version of the CAPM which allows for coskewness is:[2]

Cost of equity = Riskless rate

[2] The classic papers explaining the derivation of this result are Kraus and Litzenberger (1976) and Harvey and Siddique (2000).

+ Beta*Equity market risk premium

+ Coskewness coefficient*Coskewness risk premium (1)

In symbols this is:

$$R_{Ei} = R_F + \beta_i * EMRP + \gamma_i * CRP \quad (1)$$

Where γ_i is the coskewness coefficient for share i, and CRP is the market-wide coskewness risk premium (which is negative indicating that negative coskewness attracts a higher return). Equation (1) shows that the coskewness adjustment is made incrementally to the CAPM. In that sense it is not a replacement for the CAPM, but rather an enhancement which deals with the fact that some shares have skewness and this makes the CAPM incomplete. The adjustment for skewness (the final term of Equation (1)) is zero for a share which has zero skewness. For the majority of shares, which have zero skewness, the unadjusted CAPM is fine. For a share with positive skewness the final term of Equation (1) is negative, indicating that investors like positive skewness and, therefore, are willing to accept a lower expected return. For a share with negative skewness the term is positive, indicating that the unattractive feature of negative skewness must be compensated with a higher expected return.[3]

The adjustment is calculated as the coskewness of the share multiplied by the market-wide risk premium per unit of coskewness. This has the same form as the CAPM risk premium, which is the beta of the share multiplied by the market-wide risk premium per unit of beta. Hence the issues involved in measuring the adjustment are very similar to those involved in implementing the CAPM: estimating the coskewness of the share (rather than its beta) and estimating the market-wide co-skewness risk premium (rather than the market-wide equity risk premium).

The coskewness coefficient is defined as (Harvey, Siddique (2000) p1276):[4]

$$\text{Coskewness coefficient} = E[(\varepsilon_i)(\varepsilon_m)^2] / [\sigma_i \sigma_m^2] \quad (2)$$

Where E[.] is the expectations operator, ε_i is the residual from regression the return on share i on the return on the market (i.e. the residual from the beta regression for share i), ε_m is the deviation of the market return from its average, σ_i is the standard deviation of ε_i, and σ_m is

[3] To make these adjustments work in this way, the coskewness risk premium is negative.

[4] There are several virtually equivalent ways of measuring coskewness, which are discussed in more detail in Section 4.

the standard deviation of ε_m. Since the coskewness coefficient measured in this way is based on the residuals from the beta regression, it measures skewness effects which are incremental to the beta analysis of the CAPM. Hence it is consistent with Equation (1), where the coskewness adjustment is made incrementally to the CAPM.

3.2 Intuition of the coskewness coefficient

The intuition of the coskewness coefficient can probably be best understood by comparing it with beta. From Equation (2) above it is clear that the coskewness coefficient is, essentially, a standardised measure of the relationship between the share return, ε_i, and the square of the market return, $(\varepsilon_m)^2$. Similarly, the beta coefficient is a standardised measure of the relationship between the share return and the market return. Hence the form of the coskewness coefficient is very similar to that of the beta. However, it picks up the relationship with the squared market return rather than the actual market return.

To see why the relationship with the squared market return measures coskewness and why it matters in the cost of equity, consider the two shares shown in Table 1. The first share rises and falls in line with the market, so it has a beta of 1 and no coskewness. The second share does not go up as much when the market goes up but goes down in line with the market when it falls. Share B appears, according to the CAPM, to have lower risk because its beta is lower. This gives an incorrect impression of the risk of the share because the low beta is largely caused by the lack of upside potential.

The coskewness of Share A is zero, but the coskewness of Share B is negative. This reflects the fact that the downside risk is greater than the upside potential of Share B. The coskewness coefficient measures the covariance with the squared market return. The squared market return ignores whether the market goes up or down and just measures whether it moves a lot. So coskewness picks up the fact that when the market moves by 10% in either direction Share B tends, on average, to do badly. The average return on Share B, given a market move of 10% in either direction, is (+5%-10%)/2, which is equal to -2.5%. Hence Share B tends, on average, to do badly when there is a large market move. So it has negative coskewness, as shown for Share B. In contrast, Share A has an average return of zero given a market move of 10% up or down, so it has zero coskewness.

Table 1: Example of the impact of negative coskewness

	Share A *No coskewness*	*Share B* *Negative coskewness*
Share return when:		
Market up 10%	+10%	+5%
Market unchanged	0%	+1%
Market down 10%	-10%	-10%
Measures of risk:		
Beta	1	Below 1
Coskewness coefficient	0	Negative

3.3 High-level review of key papers

The issue of how skewness affects the cost of equity was first analysed by Kraus and Litzenberger (1976). Their model is, essentially, Equation (1) above. They found a significant coskewness risk premium (CRP) of -2.5% per annum. They also found that the CAPM augmented with the skewness adjustment explained significantly more of share price expected returns (i.e. the cost of equity) than the unadjusted CAPM. However, their empirical analysis was quite limited, so it did not provide a comprehensive basis for the use of the coskewness adjustment in practice.

An application of the Kraus-Litzenberger model to US electric utilities was made by Conine and Tamarkin (1985). They examined 60 electric utilities in the period 1971-1980. They found that using the skewness adjustment would have added an average of 1.3% to the costs of equity of these companies. Unfortunately, their estimation method relied on utility function analysis rather than an empirical estimate of CRP. This approach is generally not viewed as reliable compared with estimating parameters directly from share returns data. So the approach used by Conine and Tamarkin turned out to be somewhat of a dead-end.

The consolidation and confirmation of the Kraus-Litzenberger results came in a paper by Harvey and Siddique (2000).[5] They showed how to use modern empirical methods to do three important things. First, they showed that the coskewness effect is significant, robust,

[5] The importance of the Harvey and Siddique paper can be judged by the fact that, according to Google Scholar, it has 880 scholarly citations. This is a remarkably high number for a paper which is only ten years old.

and not simply an artefact of other known results. Second, they showed how to robustly estimate the coskewness risk premium based on share return data rather than using utility assumptions. Third, they provided a specification of the coskewness coefficient which is clearly incremental to the CAPM, as in Equation (1) above. They estimated a coskewness risk premium (CRP) of -1.9%.

Following Harvey and Siddique's contribution, there have been many other papers on coskewness and related topics. This extensive literature confirms the basic result that there is a large risk premium associated with negative skewness. One part of the literature tests various specifications of the skewness risk premium and finds that the result is very robust. Ang, Chen, and Xing (2006) use a slightly different measure of downside risk, which is related to skewness, the downside beta. They find that "the cross section of stock returns reflects a downside risk premium of approximately 6% per annum". This result is somewhat different to the coskewness result, but related. It confirms the general point that shares with significant downside and limited upside have significant additional risk premia, in addition to that captured by the CAPM. Bali, Demirtas, and Levy (2009) take a different approach, using returns to the stock market index to determine whether investors demand a premium for downside risk. They find a consistent risk premium for downside risk over "different stock market indices, different measures of downside risk, loss probability levels, and after controlling for macroeconomic variables and volatility over different holding periods".

A second important part of the recent coskewness literature is a series of papers which demonstrate that coskewness provides an explanation for well-known "anomalies" in the equity markets (as well as confirming the importance of coskewness in determining the cost of equity). These "anomalies" are features of the cost of equity such as the Fama-French factors and momentum effects. They are systematic deviations from the CAPM which had previously defied rational explanation. Chung, Johnson, and Schill (2006) and Post and van Vliet (2006) show that adding higher order comoments[6] including coskewness "reduces the explanatory power of the Fama-French factors to insignificance in almost every case". Duong and Puri (2009) show that the coskewness adjustment and other higher-order comoments can account for a number of other well-known deviations from the CAPM, including momentum and liquidity effects. Smith (2006) shows that the effect of coskewness is greater at times when the market is subject to downside shocks.

[6] Coskewness is the third comoment, co-kurtosis is the fourth, etc..

Overall, since 2000, and particularly since 2006, there has been an emerging academic consensus that coskewness matters to the cost of equity. Using the coskewness adjustment now offers a disciplined approach to making an adjustment for systematic deviations from the CAPM which were previously known to be important but difficult to quantify and explain.

3.4 Summary of Section 3

In summary, the CAPM adjusted for the impact of skewness contains an extra term, which is the coskewness coefficient of the share multiplied by a market-wide coskewness risk premium. Since 2000 there has been an emerging consensus that coskewness matters to the cost of equity. Since 2006 it has been confirmed that including the coskewness adjustment offers an approach to the cost of equity which allows for known deviations from the CAPM. The coskewness coefficient allows for the diversification effect of holding a portfolio. The coskewness adjustment is incremental to the CAPM cost of equity. For negative coskewness the adjustment is positive, increasing the cost of equity. For positive coskewness, the adjustment decreases the cost of equity.

4. Review of magnitude of the coskewness premium/discount

As Equation (1) indicates, adjusting the cost of equity for coskewness requires two inputs: γ_i the coskewness coefficient for share i, and CRP the market-wide coskewness risk premium.

4.1 Measuring CRP, the market-wide coskewness risk premium

The market-wide coskewness risk premium is the slope of the relationship between coskewness and expected returns on shares. It must be measured empirically. In this sense it is similar to the equity market risk premium, which measures the slope of the relationship between beta and expected returns on shares and must also be measured empirically.

The first estimate of CRP was provided by Kraus and Litzenberger (1976) for the US. Using monthly data for the US for 1926-1969 they estimated it to be -0.212% per month, or -2.5% per annum.[7] This estimate had a t-statistic of 1.905, significant at the 10% level. Harvey and Siddique (2000) refined and simplified the econometric analysis of coskewness. Using monthly data for the US for 1926-1969 they produced an estimate of -1.9%, significant at the 5% level.[8] Somewhat frustratingly, many of the academic studies do not provide estimates of

[7] Kraus and Litzenberger (1976) Table IIC.
[8] Table IV Panel B first line.

CRP, since they focus on testing various hypotheses rather than providing the parameter estimates which would enable the reader to make a coskewness adjustment for a particular company. I have searched for authoritative studies which estimate CRP for countries other than the US, especially for the UK, but as yet have not been able to find any.

In summary, the best available evidence indicates that the coskewness risk premium is both statistically and economically highly significant. The best available estimate of CRP is -1.9% estimated by Harvey and Siddique using US data for 1926-1929.

4.2 Estimating γ_i the coskewness coefficient for share i

Equation (2) above gives Harvey and Siddique's recommended formula for the coskewness coefficient. Measurement of this requires a time-series of returns on the share and returns on the stock market. For traded shares these are available, and the estimation of the historical coskewness coefficient for share i simply involves measuring Equation (2). This is a process which is very similar to the measurement of beta. The difference is that the coskewness coefficient is based on the standardized covariance of the share with the squared return on the market, whereas the beta is based on the standardized covariance of the share with the actual return on the market. Other than that the two measures are almost identical in form.

Hence most of the choices to be made closely parallel the choices made when estimating betas and, to be consistent, the same choices should be made in both cases. For instance, the same stock market index should be used to measure the coskewness coefficient as is used to measure beta. Also, as with the estimation of beta, when the entity under consideration is not traded on a stock market, there is the issue of how to measure coskewness when the share price is not available.

When the entity does not have a traded share price there are three ways to estimate coskewness. First, similar companies with traded shares can be used as proxies. Second, estimates based on the behaviour of earnings can be used. Third, the fundamental features of the company can be investigated as an input to the estimate. These three ways have close analogies in the estimation of beta using proxy companies, using earnings, and using fundamental analysis. For instance, the CAA has used fundamental analysis as an input to estimation of the beta of NERL (First Economics (2009) Table 4.3).

For a business in the unique position of Heathrow it is difficult to select a traded share which is a close proxy. So the two methods available are analysis of fundamentals and estimation

based on earnings. I discuss analysis based on fundamentals in the next Section. For analysis based on earnings, there is a close parallel in the estimation of beta based on earnings. The standard method of doing this is to take the growth rate of earnings as a proxy for the share return (Damodaran (2002). This should be done for both the share and for the market. Once that is done, these pseudo rates of return based on earnings can then be used in Equation (2) to calculate the coskewness coefficient in the standard way. In beta analysis this approach is relatively standard, and extending it to coskewness analysis involves only the extension to the comovement with the squared market return rather than the raw market return discussed above.

It is clear that the best measure of coskewness is one based directly on share prices. If this is not available, then a combination of evidence from earnings behaviour and fundamental analysis should be used.

5. Qualitative discussion of why this issue has not been seen as important in other regulated sectors, and why it has not been a concern of the CAA until Q5/6

Previously there no evidence has been put forward documenting significant coskewness of returns to regulated entities in the UK. In my opinion, this is because the current situation facing Heathrow is unique in UK regulatory history. Heathrow now faces a hard capacity constraint, working at effectively full capacity. There is no prospect of significantly increased capacity from a third runway. On the other hand, Heathrow's business is susceptible to significant downside because it depends on the airline business, which experiences periodic significant negative shocks. This combination of circumstances makes Heathrow different to other UK regulated entities, as BAA's analysis shows.

Furthermore, the magnitude of skewness of Heathrow's returns has increased significantly in the recent period, as BAA's analysis also shows. The capacity constraint has become increasingly binding, and since a response of raising prices is prevented by regulation, the upside is limited. The magnitude and frequency of shocks to the airline industry has increased, exacerbating the downside risk. Also, it has become apparent that Heathrow will not be allowed to build another runway, so medium-term upside from that source which existed before has been ruled out. BAA's quantitative analysis confirms this qualitative analysis of increasing skewness.

The issue of skewness has been foreshadowed in earlier CAA documents (CAA (2006) paras 2.38-2.47, 7.4). Now BAA has put forward clear evidence that Heathrow has negatively skewed returns, that the level of skewness is materially more significant than before, and that it is also materially more significant than for other UK utilities. In my opinion, the evidence of a high degree of skewness, combined with the unique situation Heathrow faces relative to other regulated entities, justifies a skewness adjustment to the cost of equity. The increasing academic consensus that skewness is relevant in this type of situation (i.e. for a firm with high coskewness) supports making such an adjustment. The increasing acceptance of the Harvey-Siddique approach to making that adjustment provides the tool with which to do it.

6. Consequences of not taking account of coskewness in the Heathrow WACC

The issue of fairness is important in regulation. There are at least three forms of fairness in this context: (1) Allowing a return which is fair in relation to the risks taken by investors; (2) allowing a return which is fair to the regulated entity relative to its customers; and (3) allowing a return which is fair relative to other regulated companies. The first is important because a return which rewards shareholders fairly is necessary to give the correct investment incentives; the second is important in order to deliver services at the lowest reasonable price; and the third is important so that investment is not distorted between regulated sectors.

In the following discussion I will assume that BAA has demonstrated that there is negative coskewness in the returns to Heathrow and that this is sufficient to justify an extra risk premium. In that situation, if only the CAPM risk premium is given then all three notions of fairness will be violated.

Regarding fairness to shareholders, Heathrow will earn a return of the same amount as an alternative investment which has the same beta but no negative coskewness. This will be inadequate to compensate for the risks taken, in the specific sense that those investors could achieve a higher return for the same risk elsewhere in the capital markets. Those alternative investments would be viewed as clearly superior to a further investment in Heathrow. That would mean that the allowed return would be insufficient return to provide a proper incentive for investment.

Given any choice between investment in Heathrow and alternative investments in other companies or the stock market, the incentive for the shareholders of Heathrow will be to favour the alternative investments. Heathrow will offer a risk-adjusted return which is below

the freely available capital market alternatives, once all relevant dimensions of risk are taken into account. The management of Heathrow would be faced with the delicate task of balancing the interests of its shareholders and customers, given that it has an inadequate allowed return to compensate fully for the risk profile it faces.

Regarding fairness to customers, there are two important issues. In the short-run customers benefit from the lowest possible price. However, this is a false benefit in the medium term if it does not provide the correct incentives to invest. Hence fairness to customers requires the correct investment incentives, which the CAPM alone does not give.

A similar issue arises with respect to avoiding distortions between regulated companies. As discussed in Section 2.4 above, if two regulated entities are allowed only the CAPM then this will be fair as long as neither has significant skewness in its returns. However, if the effect of skewness is material for one of the regulated entities the allowance of only the CAPM return will deprive it of part of the return which the equity market requires from it.

In summary, if the effect of skewness on the required return from Heathrow is material, then the fair and non-distortive approach for the regulator is to allow an extra component of the cost of equity to compensate for that.

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