THE COST OF CAPITAL ESTIMATION FOR FIXED TELECOMMUNICATIONS SERVICES

A Final Report for OFTA

Prepared by NERA

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1 INTRODUCTION

NERA was invited to carry out an estimation of the cost of capital for Investment in Local Fixed Telecommunication Network Services in Hong Kong. The ToR focused on four major issues:

- choosing an appropriate method for estimating the cost of capital,
- estimating the cost of capital of the incumbent,
- estimating the cost of capital of an entrant, and
- estimating different cost of capital for investment in broadband and narrowband services.

This report looks at the theoretical issues behind each of these issues. It goes on to outline different approaches to the calculation before drawing conclusions.

2 KEY ISSUES

2.1 Entrants vs Incumbents

Entrants' businesses may differ significantly from those of incumbent operators. Entrants are required to invest heavily in new networks when they enter a market, they have to develop brand awareness and establish a customer base. They often target different sectors of the market from the incumbent which may expose them to different risks and they may also have to raise large amounts of finance in capital markets which will affect their gearing and their credit-ratings. On the other hand, incumbents tend to have a large customer base and high brand awareness which means that the business risk differs from that of the entrant.

Our approach to this issue has been to develop a set of characteristics that distinguish an entrant from an incumbent. We have then looked at how these characteristics affect the parameters used in the cost of capital calculation. There are two key stages in this method of analysis:

2.1.1 Defining an entrant

Broadly speaking, there are two different approaches to this.

- Existing entrants

This involves looking at the existing entrants in the Hong Kong Fixed Services market and trying to develop a set of representative characteristics.

- Potential entrants

The alternative approach considers the type of companies that are the most likely to be future entrants in the Hong Kong market as it becomes progressively liberalised and assumes a set of characteristics associated with these entrants.

If the existing entrants are representative of potential future entrants then these two approaches are complementary.

2.1.2 Implications for calculating the cost of capital

The problem with both the approaches outlined in Section 2.1.1 is that there is very wide variation in the type of companies that have entered or are potential entrants in the market. Since there are only three operators in Hong Kong of wireline-based fixed networks other than the incumbent (and the cable modem service operator which was licensed in January 2000) estimating robust averages for key characteristics is difficult.

In trying to define the characteristics of a potential entrant there are many different types of international telecommunications companies which are potential entrants and it is difficult to say what would be typical. For example, an entrant might be an international company, specialising only in telecommunications or it might be part of a larger group with no specific focus on telecommunications. The financial characteristics such as betas, gearing and effective tax rates might vary considerably. Where it is not possible to say clearly how an entrant would differ from an incumbent, we have discussed possible alternatives values for parameters.

Some parameters of the cost of capital calculation would be the same for entrants and incumbents. For example, the equity premium and the risk-free rate in Capital Asset Pricing Model would be the same for all types of company in the Hong Kong market. Therefore, the first part of the analysis is to identify which parameters are likely to vary between entrants and incumbents and then to identify ways in which they are likely to vary.

Another important issue which has a bearing on the differentiation of entrants from incumbents is that of optimality. A company with a non-optimal financial structure would have a higher cost of capital than one with an optimal structure. When the cost of capital calculation is likely to be used for setting interconnection rates or price-caps the regulator has an incentive to use a cost of capital based on an efficient or optimal capital structure. For example, if the cost of capital of the incumbent is used to set interconnection rates, there is no reason why other operators should bear the cost of the incumbent's inefficient capital structure.

It is possible, in principle, to estimate the optimal capital structure of a company based on the credit rating of the company and the way in which the cost of debt and the cost of equity change with the capital structure of the company. This analysis requires consideration of market evidence on how perceptions of investors, credit rating agencies and financial markets are affected by capital structure changes. Credit ratings are driven strongly by the business and financial profile of the company. Such analysis is therefore difficult to undertake for 'potential' entrants.

Where it is appropriate, this study takes a pragmatic approach and combines both an analysis of the existing entrants and the likely characteristics of any potential entrants. Where it is not possible to estimate the likely value of a particular characteristic of an entrant, we have considered a range of possibilities.

2.1.3 Parameter values

We would expect four parameters involved in the cost of capital calculation to be influenced by a company's status as either incumbent or entrant.

2.1.3.1 Beta

It is possible that new entrants face greater business risk than the incumbent. The incumbent's revenues will be eroded as entrants' customer bases develop. However, the resulting fluctuations in earnings will likely be smaller (as a proportion of the total) for the incumbent. The incumbent's profits may therefore be less volatile than the entrants.

However, the CAPM model doesn't include directly this 'absolute' risk (i.e. the volatility of the companies profits over time).

Instead, CAPM uses the parameter beta which captures the systematic riskiness of the company.

This is a measure of the relationship between the returns to a particular company compared with the return on all other assets. Therefore, if the value of beta is higher for new entrants than the incumbent, it is because there is a stronger correlation between returns to investment in the entrant and the market return than investment in the incumbent and market return. This might be the case for several reasons:

- it is likely that new entrants will target business customers because they are more lucrative and it may be easier to develop market share amongst business customers because they potentially have more to gain and therefore have bigger incentives to switch supplier. Business demand is likely to be more sensitive to the fortunes of the market as a whole than residential demand therefore new entrants' revenues will tend to be more cyclical and so have a higher value of beta;
- even if businesses are identical, there may be a difference in investor perceptions of the systematic riskiness of entrants and incumbents. This raise the value of beta for entrants.

Beta is discussed in more detail in Section 3.2.1.2 and evidence of the difference in the value of beta for entrants and incumbents is discussed in Section 4.1.1.

2.1.3.2 Gearing

Different approaches to defining an entrant are discussed above. This has particular relevance for the estimation of gearing.

If our model of entrants is based on the characteristics of actual entrants in the Hong Kong market, then looking at gearing is just a question of considering the gearing of the existing entrants and calculating an average.

An alternative approach is to estimate the gearing of an entrant from *a priori* expectations. If an entrant was a stand-alone operator starting up in the telecommunications market in Hong Kong we would expect it to raise its capital through equity. It is unlikely that a new

company would be able to raise significant levels of debt, at the same rates as an established incumbent, through the bond market or bank loans. Specifically, new entrant's will be unable to tap international capital markets (where preferential rates may be available) for finance in the early years of operation until rating agencies have established its credentials. We would therefore expect the gearing of new entrant's to be low in the early years of operation.

If an entrant was part of a larger group, the cost of raising debt finance and the company's gearing levels would reflect the credit status of the group. It is difficult to formulate an a priori view about a typical value of the gearing for these companies since they will vary according to where the groups are based and what other companies form its constituent parts. For the same reason, it is difficult, if not impossible, to form a view of the optimal gearing of a potential entrant since this will also depend on the group's credit rating and the relationship between the cost of debt and the credit rating for the sectors that it operates in. Some evidence may be available from examination of gearing levels for new entrant's in comparable markets (eg. UK and US Telecom markets).

Overall, gearing levels may differ significantly between new entrants and incumbents. Optimal gearing is likely to be lower for a stand-alone new entrant than an established incumbent. Where new entrants are part of a larger group, the cost of raising debt finance, and hence the optimal gearing will (partly) depend on the business and financial profile of the larger group which may also differ from the incumbent.

2.1.3.3 Tax

There are several possible options for the choice of tax adjustment. The effective tax rate of the incumbent can be estimated from its accounts. However, there are arguments in favour of using the standard tax rate instead of the actual effective tax rate. These are discussed in Section 7.

It is reasonable to expect that entrants would have certain typical investment characteristics which may have an influence on the effective tax-rate that they face. For example, new entrants into the Hong Kong market could reasonably be expected to be invest heavily in capital assets when they first enter. They could also be expected to make losses in the early years of operation which could then be carried forward into later years when they are making a profit. It would therefore be reasonable to assume that new entrants would face a lower effective tax-rate.

These issues are discussed in more detail in Section 7.

2.2 Local vs. International Market Comparison

It is common practice to estimate several of the parameters in the cost of capital calculation with respect to the local market. For example, betas are usually defined as the statistical

relationship between an equity and the market in which it is traded. The implicit assumption behind this is that when an investor diversifies his portfolio, the only investment options available to him are those in the local stock market. However, the telecommunications market is an international one, as are equity markets. This means that, in practice, an investor is not limited to investment in the local stock market but can invest in any stock market around the world. It is therefore important to consider the cost of capital with respect to the world market. This applies to several of the parameters in the cost of capital calculation and so, where applicable, we have performed both national and international cost of capital calculations.

The specific details of these calculations are discussed in Section 4.

2.3 Broadband vs Narrowband

The terms of reference specifically request us to consider the possibility of estimating a separate cost of capital for broadband and narrowband businesses.

In order to do this, two questions have to be addressed:

- Is it possible to define broadband and narrowband accurately and meaningfully?
- Is it possible to make a meaningful estimate of the parameters required in order to perform a separate calculation of the cost of capital?

Answering the first question is difficult because the terms “broadband” and “narrowband” are variously defined by the means of service delivery (i.e. high capacity optical fibres, wireless links etc.) and the services provided. However, the distinction between the two types of access and services is becoming increasingly unclear. For example, xDSL technology allows broadband services to be provided over what was originally designed to be narrowband technology. In a similar way, ordinary voice telephony can be provided over broadband access systems (e.g. internet phones).

A clear definition which will continue to be relevant in the future is therefore required if a separate cost of capital calculation is to be performed.

If this is possible, then it is also necessary to make separate estimates of values for some of the cost of capital parameters. However, since these are based on historical data, we need to find examples of companies with the desired characteristics and analyse their history.

These issues are discussed at length in Section 8.

3 COST OF CAPITAL PRINCIPLES

3.1 WACC

Companies can raise capital through either debt or equity. The return required by the market for each of these two elements are likely to be different. The true cost of capital for a company is a weighted average of the two.

The weighting is done using gearing (debt / debt + equity) in the following way:

$$\text{Post-tax WACC} = g \times r_d + (1-g) \times r_e$$

where,

g = gearing = (debt / debt + equity)

r_d = the post tax cost of debt; and

r_e = the post tax cost of equity

The Post-tax WACC is the return required to persuade investors to take on the risks of investing in this company (or project). The pre-tax WACC reflects the returns that the company must earn to be able to pay investors the post tax WACC and finance tax liabilities. The pre-tax WACC is defined as:

$$\text{Pre-tax WACC} = g \times C_d + (1-g) \times C_e$$

where,

C_d = the pre tax cost of debt; and

C_e = the pre tax cost of equity

The relationship between the pre tax costs of debt and equity and the post tax costs of debt and equity will depend on the nature of the corporate tax system and the companies' tax liabilities. We discuss in more detail the relationship between the pre-tax and post-tax WACC measures in the Hong Kong context in Section 7.

3.2 Cost of Equity

The post-tax cost of equity is the return on equities (either through dividends or through an increase in the value of shares) that is required to persuade investors to invest in them.

There are essentially two ways of calculating the cost of equity – the Capital Asset Pricing Model (CAPM) and the Dividend Growth Model.

3.2.1 Principles of the CAPM

3.2.1.1 Principles

The CAPM model defines the required post (corporate) tax returns on the equity of a company in the following way:

$$E[r_e] = E[r_f] + \beta(E[r_m] - E[r_f])$$

where,

$E[r_e]$ = the expected return on equity

$E[r_f]$ = the expected return on a risk-free asset

$E[r_m]$ = the expected rate of return for the market; and,

β = a measure of the systematic riskiness of the asset.

3.2.1.2 Beta

An important aspect of the CAPM model is the underlying assumption that people can diversify their investment portfolio through purchasing other assets. The risk associated with an equity in the CAPM model (captured through the value of β) reflects only the non-diversifiable risk of that equity. It is therefore a measure of the strength of the relationship between the expected returns on an asset and the expected returns on a broad portfolio of assets.

In theory a full range of assets are available to investors and returns to all assets should be included in the model. However, in practice, the returns to the stock-market are used in the calculation as a proxy for the returns to all assets.

Formally, beta is defined in the following way:

$$\beta = \frac{\text{cov}(r_e, r_m)}{\text{var}(r_m)}$$

where;

r_e = the return on a specific stock

r_m = the return on the market as a whole

In practice, forward looking estimates of returns on particular stocks and on the market as a whole are not readily available therefore we use historic returns as a proxy for expectations about the future. Beta is estimated by regressing the return on a stock on a constant and the return on an index of the stock market as a whole.

However, using historic returns to estimate future values of beta raises the question of which is the correct period to use in the sample. It is argued that, since we are using historical data as a proxy for forward-looking expectations, we should choose the most recent period possible, since this will embody market expectations about future returns. This would lead us to look at, for example, daily data over the past one or two years.

However, it is also argued that the values of beta fluctuate systematically over the business cycle. Therefore taking only a recent period (i.e. less than one complete business cycle) risks missing information and biasing the results. According to this argument, betas should be calculated over as long a period as possible in order to smooth out the effects of long-run cycles. This is discussed further in Section 4.1.1.

It is also important to note that the value of the equity beta will reflect not only the level of business riskiness but also financial riskiness. As a company's gearing increases, the greater the variability of equity returns, since debt represents a fixed prior claim on a company's operating cashflows. For this reason, increased gearing leads to a higher cost of equity, reflected in a company's beta value.

In the CAPM framework, the traditional way to account for the impact of a change in gearing on the cost of equity is to adjust the beta coefficient in a linear manner, reflecting the fact that the variability of equity returns is directly proportional to the amount of profits paid out as interest payments. A formula is defined for unlevering betas for the UK companies which are deemed to be representative of the UK water sector. To go from unlevered (or asset) betas to levered (or equity) betas, the following formula is used:

$$\beta_{equity} = \beta_{unlevered} (1+(1-T)*(Debt / Equity))$$

where T is equal to the effective tax rate. This is discussed in more detail in section 6.1

3.2.1.3 Risk-free rate

The expected return on a risk-free asset ($E[r_f]$) or the "risk-free rate" is the return on an asset which bears no risk at all. Formally, the real risk free interest rate is the price that investors charge to exchange certain current consumption for certain future consumption. In part, it is determined by investors' subjective preferences and in part by the nature and availability of investment opportunities in the economy.

Financial theory says that the true risk free rate is one that has zero correlation with the market portfolio ie, a return on a zero beta asset or portfolio. In practice, however, there are few good proxies for a risk free asset since inflation and other factors has been shown to lead to covariance between bond and stock markets (Harrington (1987)). In an important review of the principles of CAPM application in UK regulation, Holmans (para 2.5.3) states that there is no satisfactory proxy for the risk free rate. This same problem is well documented in US applications of the CAPM (see Harrington (1987)).

Holmans goes on to say that:

> *There is general agreement among UK economists with the WSA/WCA's main conclusion that the rate of return on index linked gilts is the best proxy for the expected risk free rate."*

The reason for this is twofold. First, the yield on index linked gilts is immune from the effects of unanticipated inflation and represents an estimate of the forward looking return that investors currently require. Second, it has been argued that the returns on index linked gilts are less correlated with the market than the returns on Treasury bills and other government bonds, and are therefore closer to satisfying the theoretical requirement of having a zero beta.[1]

However, in many countries, index-linked sovereign bonds are not issued or not traded in sufficient quantities. If the government issues nominal government bonds, these can be used as the risk-free rate with an adjustment for the risk of unanticipated inflation.

3.3 Principles of the DGM

The Dividend Growth Model approach rests on the assumption that the value of an asset relies on the future cash flows it will generate. When applied to share valuation, the future dividends are the expected cash flows. The cost of capital is specified as the rate of return that equates the market price of a share with the present value of the cash flows investors expect from a share.

The normal model that is used is based on the assumption that expected future dividends follow a constant future growth path. This model, known as the "simple DGM", estimates the cost of equity as:

$$r_e = D_1 / P_0 + g$$

which states that the cost of equity (r_e) is equal to the sum of the expected dividend yield (D_1 / P_0) at the time of purchase and the expected growth rate of dividends (g) into the future.

[1] This point was made by Stephanie Holmans in Ofwat RP5 (1996) , Section 2.5.

The difficulty in applying the DGM to estimate the cost of equity for HK Telecom companies is that, in view of the dynamically changing market, there is a very great degree of uncertainty over the value for the expected growth rate of dividends. Normally two approaches are taken:

- Analysis of historical growth rates of dividends of the company;
- Analysis of market evidence such as analysts' expectations, or by expectations about future growth in the general economy.

Historical growth rates of dividends are unlikely to be a realistic representation of future dividends for HK Telecom companies.

Analyst forecasts of future dividend streams also rarely extend beyond two to three years. We do not consider that it is appropriate to use such forecasts to estimate a cost of equity using the "simple DGM" stated above since in view of the dynamically changing market future dividend streams are unlikely to be constant. For new entrant's dividends may be expected to be very low in the early years of operations and then grow at faster rates as the company and the market "matures". But there is a great deal of uncertainty about this time path meaning that any attempt to apply the DGM will lead to large range of estimates for the cost of equity.

Analyst expectations of dividend growth rates expectations will depend to a large degree on what the analysts view of the likely outcome of a price review. There is hence a large degree of circularity in using the DGM in determining the cost of capital to be used in a price review for a regulated company.

In view of these difficulties we have not sought to apply the DGM to estimate the cost of capital for HK Telecom companies in this study

3.4 Principles for Estimating the Cost of Debt

The cost of debt can be expressed as the sum of the risk free rate and the company specific debt premium. The company specific debt premium is driven by the ratings which specialist credit rating agencies, such as Standard & Poor's (S&P's), assign to that company.[2]

In essence, credit ratings are based on a number of financial characteristics such as market capitalisation, earnings volatility, and business risks specific to the company and/or the sector. However, particular regard is paid to the following two financial ratios:

[2] Some companies, particularly large and well known, choose not to be rated but still access the capital markets for debt at appropriate levels.

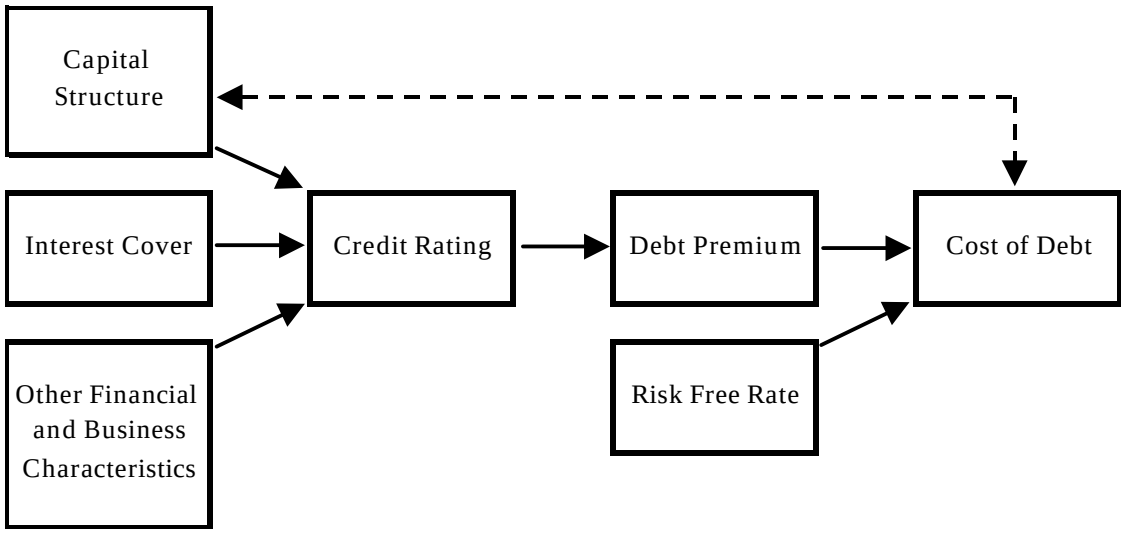
- Funds From Operations (FFO) interest coverage; and
- Interest Coverage defined on earnings basis (EBIT).

Interest cover, defined as the number of times by which a company can meet its interest payments out of operating profits, is essentially a measure of the surety of interest payments being met. A company with low interest cover is less likely to maintain a premium credit rating, since the probability of default on interest payments will be relatively high. S&P's particularly emphasises funds flow interest coverage as a rating criterion.

A company with a high gearing ratio is also less likely to maintain a premium credit rating. This reflects the fact that the probability of default on interest payments will be higher if gearing is high. It is clear that credit rating agencies, in determining credit ratings, are concerned primarily not with capital structure per se, but rather with debt service coverage levels, measured on both a cash flow and earnings basis. [Relationships between gearing and interest coverage will differ across companies according to the specific finance arrangements.]

Figure 3.1 summarises the postulated relationships between gearing and interest cover, credit ratings, other business and financial characteristics and the debt premium and cost of debt.

Figure 3.1
Relationship Between Capital Structure, Interest Cover, Credit Rating and Cost of Debt



In Section X we estimate the cost of debt for HK Telecom Companies by considering both the actual observed costs of debt for those companies and comparable companies and also by considering how the cost of debt changes as capital structure changes.

3.5 Principles for Estimating Gearing

Finance theory says that the appropriate discount rate for expected future cash flows is the Weighted Average Cost of Capital (WACC) which represents a weighted average of the expected costs of debt, equity and hybrid financing.

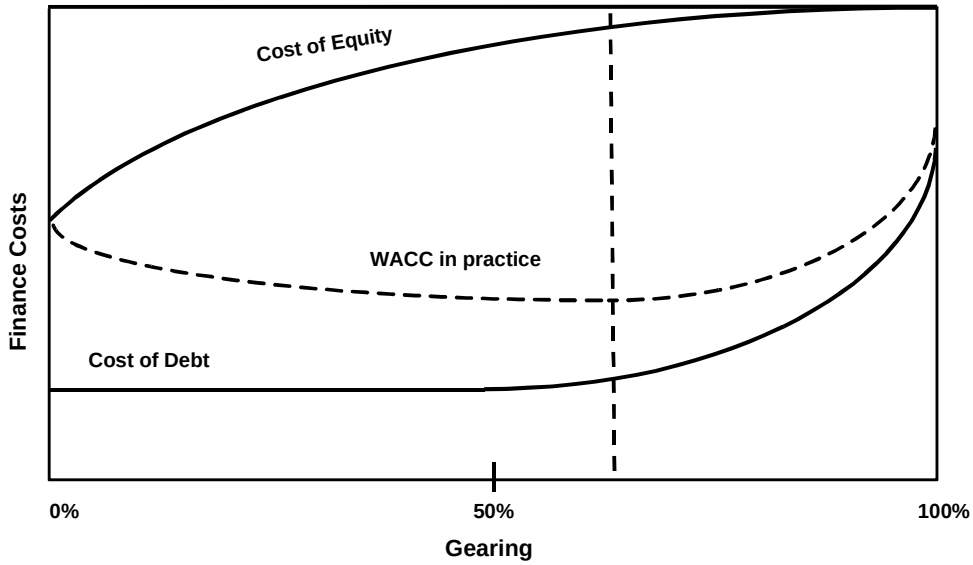
It is now generally accepted that changes in the proportion of debt and equity in the balance sheet can, in practice, have significant implications on a company's overall costs of finance. This is the result of a number of factors that occur when gearing is changed:

- Debt risk and interest rate changes;
- Equity risk changes;
- Probability of future default changes;
- Tax position (personal and corporate) changes;
- Investment strategy may change.

Academic theory cannot predict what proportion of overall finance should be raised through debt or equity. In general terms, debt is advantageous because of its low costs and tax deductibility but can be disadvantageous where personal taxes and bankruptcy costs are concerned. The optimal capital structure of a company will normally consist of a mixture of debt and equity finance.

Companies with stable cash flows and low risk profiles can absorb more debt into their balance sheets than most other types of companies. However, to assess the optimal capital structure of a utility, an empirical analysis is required that examines market evidence on how the perceptions of investors, credit rating agencies and financial markets in general are affected by capital structure changes.

Figure 3.2
Does Capital Structure Matter?



In assessing "optimal" capital structure it is important to focus not only on central case scenarios but also on downside scenarios. The possibility, for example, that capital expenditure may be substantially above central case projections may mean that an "optimal" capital structure will allow for unused borrowing capacity to increase debt in adverse circumstances. Some trade-off is likely to exist between minimising the average cost of new finance and minimising the *possibility* of financial distress and bankruptcy.

4 THE COST OF EQUITY

4.1 CAPM

4.1.1 Beta

4.1.1.1 Local and international estimates of beta

One of the objectives of this study is to calculate both a domestic and international estimate of the cost of capital. We have therefore calculated two different values of beta – one with respect to the Hong Kong stock market and the other with respect to the world stock market.

To do the calculation, we use the total return (i.e. inclusive of dividend income) on the common stock of CWHKT, for the period January 1988 to February 2000. We regress this series on a constant and on the return on two indices: the total return on Datastream HK market index to derive a domestic beta and against the total return on the Datastream world capital market index to derive an international beta.

As discussed in Section 3.2.1.2, there is a debate over which is the correct period of data to use. In order to generate a statistically significant estimate of the value of beta, it is important to have a reasonable sized data set. If the estimate of beta is based on recent historical data, then daily or weekly data is required in order to provide a sufficiently large sample size. However, if the value of beta is to be estimated over a longer period, then monthly data is sufficient. The disadvantage of daily data is that it can introduce a variety of biases associated with thin trading, serial correlation of market returns and asynchronous price adjustment processes. Studies have shown that infrequently traded securities are likely to be biased downwards for these reasons.

This raises two related issues – which frequency of data to use and which period to choose for the estimation of beta.

In order to address the first of these issues, we calculated domestic and international betas on daily, weekly and daily data for the full period for which we have data (1988 – 2000). The results of this analysis are shown in Table 4.1.

Table 4.1
Results of CWHKT Beta Estimations (January 1988-2000)

	Beta with respect to Hong Kong Stock market	Beta with respect to the World Stock markets
Daily data	0.88	0.73
Weekly data	0.87	1.05
Monthly data	0.78	1.02
Average	**0.84**	**0.93**

Source: NERA analysis

The data shows no clear relationship between the frequency of the data and the estimate of beta. Daily and weekly data produce similar results for the Hong Kong estimate of beta. However, weekly and monthly data produce similar estimates of the world beta.

These estimates are done over the same period (i.e. 1988-2000) therefore these differences are not related to changes in beta over time, but are only related to the frequency of the sample data. Since it has been observed that using daily data can be misleading (as evidence by the lower daily beta for the world market), we concentrate on the weekly and monthly data.

In theory, when using historical data, the best predictor of the value of beta in the next period should be the value over the most recent period of history. However, if there are systematic changes over time (i.e. a long run trend) then using a long period average would not provide the best estimate of future periods. On the other hand, if the value of beta is subject to random fluctuations over time, the long period average is the best estimator of future values. In order to investigate this we calculated betas based on weekly data for two year periods over the period 1988 – 2000. The results are given in Table 4.2.

Table 4.2
CWHKT Weekly Betas Calculated over Different Sample Periods

	Beta with respect to the Hong Kong market	Beta with respect to a world market index
1988-1990	0.66	0.56
1990-1992	0.88	0.67
1992-1994	0.94	0.90
1994-1996	0.84	1.54
1996-1998	0.88	1.99
1998-2000	0.95	1.18
1988-2000	**0.87**	**1.05**

Source: NERA analysis

These numbers show that there is no clear trend in the values of beta over time. We also looked at whether betas are sensitive to the market index that is chosen by calculating a beta based on the Hang Seng Index:

Table 4.3
Weekly Betas for CWHKT Over Alternative Market Indices

	Datastream Index	Hang Seng Index
1988-2000	0.87	0.82

Source: NERA analysis

However, several observations can be made about these results.

- World betas show a significant peak in the 1996-1998 period. It is possible that world betas are more cyclical and therefore the higher values in 1994-1996 and 1996-1998 reflect the economic bust and Asian financial crisis.
- Hong Kong betas are more stable over time than world betas.
- The use of an alternative market index does not change the results significantly. However, we favour the use of the datastream index for its more complete coverage.

There is no simple explanation for this pattern. It is possible that, since telephone companies are international companies, they are more strongly influenced by world economic conditions than the local conditions. The share price of Cable and Wireless HKT may therefore partly reflect the market's view of the parent company as well as the performance of Cable and Wireless HKT itself.

Another way of considering which is the best estimator of beta in the next period is to look at the historical data to see whether the long-period average or the values in the previous period would have the best estimator of beta. We did this and found that neither was significantly better than the other.

However, one point to note is that, compared to the range of values over the full period, the long-period average is relatively close to the value for the 1998-2000 sample. We therefore use an average of the 1998-2000 sample (using weekly data intervals) and the 1988-2000 sample (using weekly and monthly data intervals) in our estimation of the cost of capital. The 10 year estimates used here are themselves an average of the weekly and the monthly rate.

The results of this calculation reported in Table 4.4.

Table 4.4
"Best Estimates" of CWHKT Equity Betas

	Beta with respect to the Hong Kong market	Beta with respect to a world market index
1988-2000	0.83	1.04
1998-2000	0.95	1.18
Average	**0.89**	**1.11**

Source: NERA analysis

Table 4.4 shows that CWHKT betas with respect to the world stock market index are, on average, higher than with respect to the Hong Kong market. This observation seems to be fairly robust over the different sample periods, and data frequency.

Note also, that since the gearing for CWHKT is approximately zero then the equity betas will be equivalent to CWHKT unlevered betas.

4.1.1.2 Beta for entrants vs incumbents

Estimating a value of beta for the incumbent is relatively straightforward since we use the actual share-price history of CWHKT in order to perform the estimation. However, for the entrant, it is more difficult for the reasons discussed in Section 2.1.

As we argued in Section 2.1.3.1, we might expect entrants' betas to be higher than incumbents because of the nature of their businesses. However, quantifying this is difficult.

Table 4.5 shows betas for a cross-section of telecommunications companies around the world.

Table 4.5
Estimates of beta for Worldwide Telecommunications Companies

	Equity Beta	Gearing	Eff Tax Rate	Unlevered Beta
C & W HKT	***0.86***	***0.95%***	***12.17%***	***0.85***
UK				
British Telecom	1.43	11.39%	29.97%	1.31
Cable and Wireless	1.67	17.10%	19.53%	1.43
Vodafone Airtouch	1.60	1.14%	26.06%	1.59
C & W COMMS	1.21	18.64%	0.00%	0.98
Colt Telecom	2.27	6.07%	0.00%	2.13
Energis	2.2	4.09%	2.80%	2.11
Kingston Comm	1.41	0.00%	30.86%	1.41

	Equity Beta	Gearing	Eff Tax Rate	Unlevered Beta
Euroland				
Deutsche	1.19	14.95%	50.31%	1.09
Telefonica	1.25	21.05%	6.69%	1.00
Telecom Italia	1.24	8.05%	43.02%	1.18
Singapore				
Singapore Tele	0.50	0.26%	24.12%	0.50
Denmark				
Tele Danmark	1.43	10.02%	42.74%	1.34
New Zealand				
Telecom NZ	1.11	17.28%	33.28%	0.97
USA				
AT & T	0.91	17.41%	48.55%	0.82
MCI Worldcom	0.96	13.22%	41.39%	0.88
Sprint	0.60	9.40%	37.93%	0.56
Bell Atlantic	0.56	20.13%	37.80%	0.48
Bell South	0.37	14.89%	37.17%	0.33
US West	0.62	26.07%	42.06%	0.51
Japan				
NTT	1.36	11.83%	56.40%	1.28
KDD	0.60	25.99%	6.94%	0.45
Hong Kong				
Smartone	0.50	0.00%	5.07%	0.50
CITV Telecom	1.53	5.37%	19.00%	1.46
Australia				
Hutchinson	1.23	0.00%	0.00%	1.23

Source: NERA analysis of Bloomberg data

The equity betas are calculated on the basis of the relationship between the stock price of the companies and the local stock market as a whole. Note that the value of the equity beta reflects two types of "riskiness":

- "Business riskiness": As the level of business risk increases, profit streams become more sensitive to changes in general economic conditions and hence company returns become more highly correlated with market returns.
- "Financial riskiness": As the gearing ratio (D / D+E) rises and the company issues more debt, the fixed interest costs on debt increase meaning that profit streams also become more volatile leading to a rise in beta.

In order to be able to compare levels of business riskiness across companies, it is necessary to calculate the ungeared or "asset" beta of the company. The unlevered beta of the company is defined as the value of beta for the company on the assumption that the company holds no debt. Standard formulae are normally used to adjust the unlevered beta for the level of gearing of the company.

In the event that a company is expected to increase its level of gearing in the future, it is necessary to adjust the observed equity beta for the higher level of financial risk that will result from the higher gearing. In practice this is done by first calculating an unlevered beta based on the current (and historic) gearing levels and then "re-gearing" the beta for the higher (expected) future gearing levels. It is important to emphasise that the value of beta needs to be consistent with the assumed level of gearing, in order that equity holders are rewarded for the levels of financial risk to which they are exposed.

There are two approaches to formulating a view on the value of beta for a potential entrant. It is possible to look at other countries around the world and compare the betas for entrants and incumbents. The other is to consider the values of beta for international telecoms companies and base our estimate of the entrant's beta on theirs since they are the most likely entrants in the future.

The incumbents in the UK are BT and Kingston Communications. Their average beta is 1.36. The average beta for the other companies is 1.65. This would imply that entrants have a slightly higher betas (approximately 20%) than the incumbent which is consistent with our a priori expectation that the beta for entrants is higher than the beta for incumbents. However, the sample set is very small.

Looking at the values of beta for other companies around the world, one fact is immediately obvious is the level of variability between companies. The values of unlevered beta for the companies listed in Table 4.5 ranges from 0.33 for Bell South to 2.13 for Colt Telecom. This is a wide variation in the actual betas for companies which are potential entrants into the Cable and Wireless HKT (by virtue of being major international telecommunications companies). The simple mean of the values of unlevered beta shown in Table 4.5 is 1.06.

If we apply the 20% difference to the value of beta reported in Table 4.4 for Cable and Wireless HKT we get a value of the equity beta for entrants of 1.07.

Analysis of potential entrants' betas with respect to the world market was not possible, therefore we have adjusted the local market beta by the same factor that was used for the incumbent (Table 4.4). This gives an international beta of 1.33 for entrants.

4.1.2 Equity premium

4.1.2.1 Hong Kong equity premium

The equity premium is the return on 'the market' above the return on a risk-free asset which is required to compensate for the additional risk of holding these assets. In the CAPM model described in Section 3.2.1, the equity premium is given as $E[r_e]-E[r_f]$. As discussed above, the CAPM model is a forward looking model and the parameters should therefore be based on expectations about future returns. However, since data on expectations is not readily available, the usual approach is to use data on historical returns as a proxy for expectations about future returns.

The basic approach to calculating the ex-post equity premium is therefore to consider a time-series of market returns. This is done by looking at a stock-market index and calculating the returns over time. In each period, we subtract the risk-free rate of return from the return to the stock market to give the equity premium at that point in time. The average of this is then used as the proxy for the expected future equity premium.

Therefore in order to perform the calculation, two sets of data are required – the return on the market and the return on a risk-free asset over a similar period of time.

4.1.2.1.1 Data on the market returns

In order to calculate this equity premium on the domestic market, we use a broad domestic stock-market index as a proxy for all available assets - the Datastream HK market index, adjusted for dividend income. It should be noted that the Datastream total market index, unlike alternative indices, includes dividend payments and it also has complete market coverage.[3]

Table 4.6
Comparisons of Historical Equity Returns

	Total Returns on Datastream Index	
	Arithmetic Mean	***Geometric mean***
1991:2000	28.17%	22.27%
1988:2000	26.22%	21.13%
1976-2000	27.48%	21.26%
1973-2000	21.79%	14.43%

As a sensitivity we have also looked at total returns on the Hang Seng Index:

Table 4.7
Comparisons of Historical Equity Returns

	Total Returns on Hang Seng Index	
	Arithmetic Mean	***Geometric mean***
1973-2000	21.54%	13.96%

[3] We also looked at estimating the equity risk premium based on the Hang Seng Index. Our calculations showed that the results were very similar. Data on total market returns is not available from datastream before 1973.

Our calculations showed that the results were very similar over this period.

4.1.2.1.2 Data on the risk-free rate

In June 1991, the Hong Kong Monetary Authority (HKMA) began issuing exchange fund bills and notes (EBF&N). Data on 91 day EBF&Ns are available from June 1991, but 10 year EBF&Ns are only available from October 1996. Therefore the data on equity market returns is available over a longer period than that for the risk-free assets. In order to calculate the equity premium over a sufficiently long period, it is necessary to generate a proxy for the 3 month and ten year risk free rates in Hong Kong.

One method of doing this would be to average the series over the sample that we have and use this average as the proxy risk-free rate over the sample where data is not available. However, the 1990s have experienced low inflation relative to the 1970s and 1980s and nominal interest rates have been low compared with recent historical precedent. Therefore an average of this kind will certainly underestimate the 'true' risk free rate over this period. For example, the average yield on 3 month EBF&Ns between June 1991 and February 2000 was 5.03%.

We have therefore generated estimates of the historical risk-free rate in the following way. Under certain conditions it can be shown that by invoking the theory of *Uncovered Interest Parity* and *Purchasing Power Parity* that the difference between long government bond rates is equivalent to the expected inflation differential between the two economies. Therefore a rudimentary proxy for the difference between the US government and HKMA's ten year bond rates will be the inflation differential between the economies. Therefore by adding the difference between HK and USA CPI inflation to the yield on ten-year US Treasuries, we get an approximation to the yield on HKMA ten-year bond rates. Since the HK CPI begins in January 1976, we can derive the series back to this point. We have therefore used this rate as a proxy for the risk-free rate of return to calculate the equity market risk premium in Hong Kong. Over the full sample period for which we have data available for this variable – February 1973 to February 2000 – the geometric average of this proxy variable was 9.36% (the average for 10 year US government bonds is 8.5%).

We applied the same procedure to the three month EBF&Ns - adding the inflation differential to the three month US T-Bill rate and using this as the proxy for the short risk free rate. Over the full sample period for which we have data available for this variable – February 1973 to February 2000 – its arithmetic average was 8.09% (the average US 3 month TBill is 6.98%).

In order to check the accuracy of this proxy risk-free rate, we compared the predicted values with the actual values over the period for which they are available. In the Period 1996:10 to 2000:2, the actual 10 year HKMA bond rate was 7.75% whereas the predicted values were 5.71%. For the period 1991:6 to 2000:2 the Average actual 3 month HKMA rate was 5.03% whereas the predicted rate was 6.16%.

It appears that this proxy risk-free rate appears to under estimate the actual Hong Kong rate on 10 year bills and underestimates the rate on 3 month bills. One explanation of the underestimation might be the failure to take account of country specific risk.

Estimating country specific credit risk is best done using swap rates between fixed and floating rate government bonds as follows: define w as the swap rate for an interest rate contract on government bonds in which the interest payments of a variable rate government bond with 10 years to maturity are exchanged against the interest payments of a fixed rate government bond with the same years to maturity. The credit risk is defined as the difference between the redemption yield on long term [4]government bonds, ry and the swap rate: cr = ry - w.

We measure the amount of credit risk in Hong Kong relative to the US. The difference between this spread in the US and Hong Kong is a measure of the credit risk in Hong Kong. Unfortunately swap rates are only available for Hong Kong over the period December 1998 until the end of 1999. For this period the credit risk of Hong Kong relative to the US is on average 0.767% per annum.

This suggest that an additional 77 basis points should be added to the Hong Kong rate when we use the inflation differential to estimate the Hong Kong interest rate. This is because the use of inflation differential to estimate the interest rate ignores credit risk.

[4] We have followed normal convention of using two combinations of risk free rates and the equity risk premia are usually seen: (a) long term risk free rates plus geometric means or (b) short term risk free rates plus arithmetic means.

Table 4.8
The HK Equity Market Risk Premium in HK Dollars Using Proxies for the Risk Free Rate Generated from Inflation Differentials.

Sample period	Reason	Average Total Returns on HK Equity Market	Average World Risk Free Rate	HK Country Specific Risk Premium	Calculated HK Equity Market Risk Premium
Arithmetic mean					
1973:2000	Recommended 1	21.79%	8.09%	0.77%	*12.93%*
1976:2 2000:2	Recommended 2	27.48%	8.55%	0.77%	*18.16%*
1988:1 2000:2	Listing of CWHKT	26.22%	7.24%	0.77%	*18.21%*
1991:6 2000:2	Start of 'real' Rf rate for HK	28.17%	6.55%	0.77%	*20.85%*
Geometric mean					
1973:2000	Recommended 1	14.43%	9.36%	0.77%	*4.30%*
1976:2 2000:2	Recommended 2	21.26%	9.86%	0.77%	*10.63%*
1988:1 2000:2	Listing of CWHKT	21.13%	8.54%	0.77%	*11.82%*
1991:6 2000:2	Start of 'real' Rf rate for HK	22.27%	7.93%	0.77%	*13.57%*

Notes:

1. The Equity Risk Premium is calculated as: Average Total Returns on HK Equity Market – (Average World Risk Free Rate + HK Country Specific Risk Premium)
2 The risk free rates presented in this table are used only to calculate the equity risk premium and not consistent with the risk free rate derived in section 4.1.3. For purposes of estimating the equity risk premium it is necessary to estimate a risk free rate over the same historical period as the historical equity returns. By contrast, the risk free rate presented in section 4.1.3 is the best "forward looking" estimate of the risk free rate based on most recent data.[5]

[5] The approach we have used here is known as a "semi-ex ante" approach to estimating the cost of capital first proposed by Jenkinson (1993) and now used by many UK regulators. It is implicitly assumed in this methodology that the equity risk premium stays constant over time, and therefore that the risk free rate and equity returns are correlated over time.

There are no "right" historical time periods to use for estimating the equity risk premium. The equity risk premium for use in cost of capital calculations is a forward looking concept, measuring the returns that investors require to compensate for market equity risks. A method that uses ex post realised returns as proxies for ex ante expectations can only be justified if the expected equity risk premium is constant over the period considered and is expected to remain constant in the future. In addition the errors must be independent and there must be sufficient observations to reduce the standard error of the mean of the distribution to a reasonable size.

Using long term historic averages is most likely to overcome the possibility of systematic bias between expectations and outturns. For this reason, we recommend that more emphasis should be placed to the estimates of the equity risk premium based on historical periods 1973:2000 and 1976:2000. The recommended results are summarised as:

Table 4.9
Summary of Estimates of HK Equity Risk Premium Based on Historical Data

	Arithmetic mean	Geometric mean	Average
1973:2000	12.93%	4.30%	
1976:2000	18.16%	10.63%	
Average	**15.55%**	**7.47%**	**11.5%**

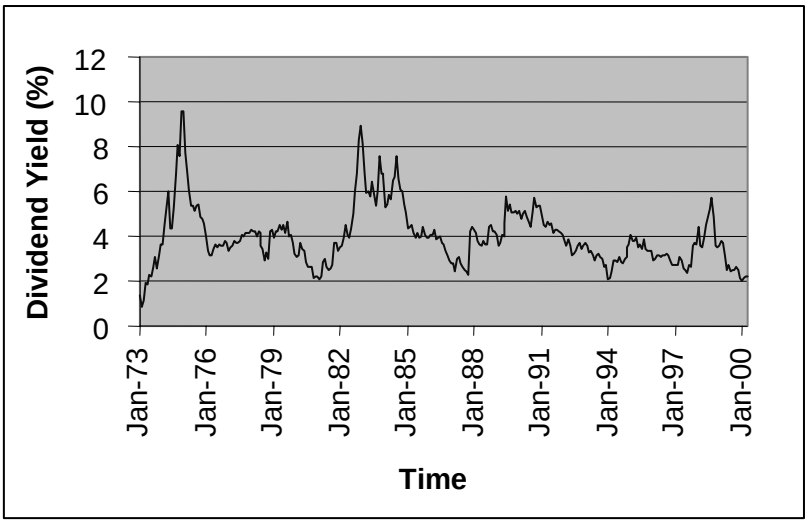
Owing to the large differences between the results – owing to the negative equity returns in the early seventies – we have chosen to take an average of the result from the two time periods.

4.1.2.1.3 Other evidence

We have also looked at market evidence on how the equity risk premium has changed since 1998. A common approach to looking at how equity risk premia change over time is to define the equity risk premium as the current dividend yield plus the long term average growth rate of real earnings minus the real bond yield.

The following diagram shows how dividend yields have moved over the period since 1973.

Figure 4.1
HK Datastream Index Dividend Yield



This diagram shows that the HK dividend yield has moved around between 2% and 4% in the last two years, peaking during the period of the "Asian Crisis" in 1998, as stock prices fell. Figure 4.2 below above shows that real HK bond yields have fallen back to "normal levels" following the "currency crisis".

Overall, if we assume that real expected long term earnings growth has remained constant since 1998, the evidence suggests that the equity risk premium has since recovered since the Asian crisis, as prices have risen and more confidence has returned to the stock market. This suggests that the "Asia Crisis" has had no long term effect on required equity returns.

4.1.2.1.4 Arithmetic vs. Geometric means

Arithmetic means are calculated by summing the returns over the period and taking a simple mean. Geometric means are calculated by taking the starting point and calculating the average compound rate of return over the period that would arrive at the end point. To elaborate on this, the geometric mean of equity returns over the period 1973:2000 is calculated as the average compound return over the period 1973 to 2000.

The geometric mean answers the question of what constant rate of return an investor would have to achieve in each year to have his or her investment match the returns on the stock market over the period chosen. By contrast, the arithmetic mean answers the question of what growth rate is the best estimate of the future amount of money that will be produced by continually reinvesting in the stock market.

There is no conclusive answer to the question of whether arithmetic or a geometric means should be used. The geometric mean describes the past investment experience exactly. However, the arithmetic mean of all future outcomes is the expected value. If you believe returns in the future will have the same distribution as in the past , then the arithmetic mean

will give you the statistically correct expected value. In practice two combinations of risk free rates and the equity risk premia are usually seen: (a) long term risk free rates plus geometric means or (b) short term risk free rates plus arithmetic means. Nothing in theory points to the use of one or another, they are artifacts of practice. The academic debate is summarised in Appendix A.

It is clear that the estimates of the equity premium based on arithmetic means are larger than for the geometric equivalents. It is our view that, on balance the arithmetic mean approach is preferable. However, there is no conclusive evidence that one is preferable to the other and we note that regulators and operators have taken different approaches to these issues in the past.

4.1.2.1.5 Conclusions on the Equity Risk Premium for Hong Kong

NERA's Cost of Capital report for OFTA, dated September 1998, estimated an equity risk premium for Hong Kong of 8-12%. This was based on similar historical evidence as above, as well as other estimates of the ERP at this time. In particular, it was noted that the equity premium used in other cost of capital determinations for other Hong Kong utilities has been 11.7%.

The evidence that we have considered in this report for the equity risk premium is similar to the 1998 report, and considers historical equity returns over varying time periods. We note that:

- In this report we have looked at historical evidence on equity returns using the datastream index rather than the Hang Seng Index. The datastream index is preferred for its more complete coverage, but we note that the results are very similar.
- In this report we also provide a more robust estimate of the risk free rate over historical time periods, and we attempt to quantify the size of "Hong Kong " country specific risk using evidence on swap rates.

Based on all this evidence, and in particular the detailed analysis of historical data, we do not feel that there is sufficient evidence to revise our previous estimate of equity risk premium from the range of 8 to 12%.

4.1.2.2 The World Equity premium

As discussed in Section 2.2, equity markets are international and most telecommunications companies are also international. It is therefore important to consider the equity risk premium from an international point of view.

In order to do this we have taken an index which reflects the returns to an international portfolio of stocks and compared that with the international risk-free rate.

4.1.2.2.1 Data on market returns

We choose an index which captures the majority of the world's traded equity, and which reflects both changes in capital value and dividend income. We use the monthly total return on the Datastream world capital market index which includes dividend income. This index begins in January 1973 and has the advantage over other indices of full market coverage. In order to calculate the world equity market risk premium we use the index from January 1973 until February 2000. The index is denominated in HK dollars.

4.1.2.2.2 Data on the risk-free rate

As a proxy for the risk-free rate of return over this sample period we use the monthly the yield on 3 month US government Treasury Bills when calculating arithmetic means and the monthly yield on 10 year constant maturity US government bonds when calculating geometric means.

4.1.2.2.3 Results

The results of the estimation of the international risk-premium are described in Table 4.14

Table 4.10
The World Equity Market Risk Premium

	Sample period	Reason	Equity market risk premium
Arithmetic mean	1976:2 2000:2	Beginning of HK Stock market data	9.82%
	1988:1 2000:2	Listing of CWHKT	7.06%
	1973:1 2000:2	**Full Sample**	**7.52%**
Geometric mean	1976:2 2000:2	Beginning of HK Stock market data	7.68%
	1988:1 2000:2	Listing of CWHKT	4.94%
	1973:1 2000:2	**Full Sample**	**5.35%**

4.1.2.2.4 Analysis of the results

For both the arithmetic and the geometric means, the full sample values tend to be at the lower end of the range. They are a bit higher than the smallest sample (1998 – 2000) and significantly lower than the 1976 – 2000 sample. This is due to the stock market crash which occurred in 1975.

As was the case in the analysis of Hong Kong equity premium, we recommend the use of the longest sample period possible.

4.1.2.3 Comparison of national and international equity risk premia

The figures in Table 4.11 are a summary of the figures presented Table 4.9 and Table 4.10.

Table 4.11
Summary of Historical Evidence on Equity Premia Estimates

	Hong Kong equity premium	World equity premium
Arithmetic average	15.6%	7.5%
Geometric average	7.4%	5.4%
Average	**11.5%**	**6.5%**

It is clear from Table 4.11 that the Hong Kong equity premium is significantly higher than the world equity premium. This is to be expected since the world premium implies full integration of capital markets. Full integration allows for the possibility of increased risk sharing and diversification benefits. This should lower the return demanded by equity holders since they can share risk across national markets through diversification. This is in contrast to local market equity risk premia which essentially assume markets are completely segmented from one another and no risk sharing is possible. Therefore the choice of which equity premium requires a view on whether markets are assumed to be integrated or segmented. It should be noted that in reality markets could be partially integrated and in this case the equity cost of capital for a Hong Kong firm may be a combination of both the local and world beta.

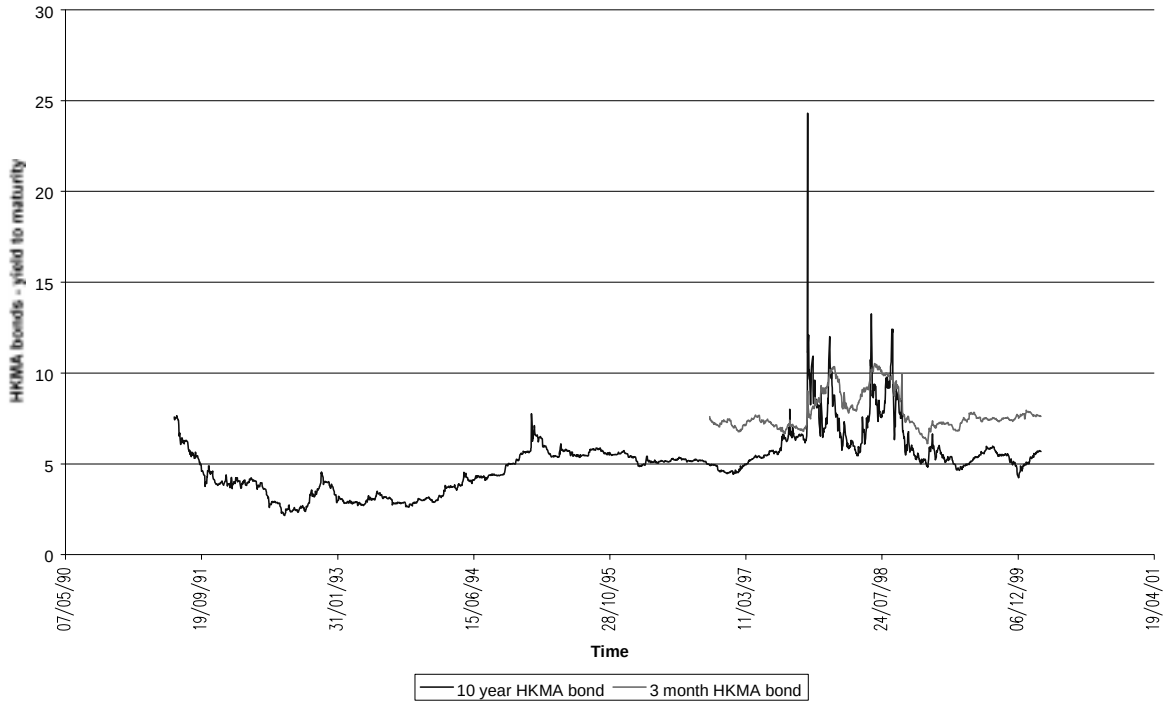
4.1.3 Risk-free rate

4.1.3.1 Hong Kong risk-free rate

As with other parameters in the CAPM, the risk-free rate is a measure of expectations about future returns on a risk-free asset. In theory this is captured by the current yields on bonds which embody expectations about future returns. However, yields on bonds can show considerable volatility and therefore current risk-free rates are significantly out of line with historical rates.

Figure 4.2 shows the yields on 10 year and 3 month HKMA bills over the period for which they have been available.

Figure 4.2
Yields on 10 Year and 3 Month HKMA Bills



It is not possible to discern any obvious long-term trends in yields. However, it is clear that there was a significant increase in the level and the volatility of yields on both types of bond during 1998. This is related to the Asian financial crisis where investors would have sold sovereign bonds from emerging markets which would lower prices and push up yields.

Any average of bond yields which includes this period will result in a higher risk-free rate than would otherwise be the case. This is shown in Table 4.12 which shows average yields calculated over different periods.

Table 4.12
Effect of Time Period on Estimate of Risk-Free Rate

	3 month HKMA bonds	10 year HKMA bonds
Average for 10/1991 - 2/2000	5.03	
Average for 10/1992 - 2/2000	5.21	
Average for 10/1994-2/2000	5.88	
Average for 10/1996-2/2000	6.13	7.80
Average for 10/1998-2/2000	5.41	7.36
Current rate	**5.68**	**7.61**

Figure 4.2 shows that yields in 1998 were not representative of the other years in the sample. It is possible that there will be another crisis at some point in the future, therefore it would be wrong to disregard the effects completely. However the market's expectation about future crises should be embodied in the current rates. It is possible that the reason that 10 year Hong Kong bond yields are slightly higher in the post 1998 period than in the pre-1998 period is that the market has slightly higher expectations of a future crash than before the previous one. This observation doesn't apply to 3 month bonds. However, this would be expected if investors were confident about the stability of the market over the short term.

The estimation of the risk-free rate in Hong Kong therefore raises two issues:

- which is the correct type of bond to use as an estimator of the risk-free rate; and,
- whether it is correct to use the current yield or an average of historic yields on government bonds in order to estimate the risk-free rate.

Bond Type

The correct type of bond to use as the risk-free rate is a subject which generates a considerable amount of debate in other countries when determining the cost of capital. The discussion usually focuses on whether the bonds should be a similar maturity to the life of the relevant assets or whether they should match the regulatory review period. Since it is often not possible to reach agreement on this issue, yields on medium and long-term bonds are often used as limits for the value of the risk-free rate.

In the Hong Kong case, we understand the HKMA now issues 91-, 182-, and 364-day Exchange Fund Bills, and 2-,3-,5-,7-,10-year Exchange Fund Notes. There is no correct maturity to use when estimating the risk free rate to be used in the CAPM. Short term bonds often have lower yields, as reflected by the upward sloping yield curve.

It is normal regulatory practice to use yields on medium and longer term bonds, between 5-30 years, as an estimate of the risk free rate. We note however that the HKMA does not issue bonds with maturities greater than 10 years at present. We also note that the HKMA 10 year bond is referred to as the benchmark Hong Kong bond and has been traded over the longest period since 1991, and therefore likely to be less susceptible to illiquidity concerns.

By way of comparison, we also consider the effect of estimating the risk free rate using yields on 3-month risk Exchange Fund notes.

Current Yield vs Average Yields

Economic theory says that the current yield on bonds reflects the market's expectations about the future therefore this is theoretically the best measure for CAPM. However, there is also evidence that yields shown random fluctuations over time due to, amongst other things,

thin trading. A long-period average avoids this problem and is sometimes a better predictor of future yields than the current yield. However, using a historical average picks up the effects of abnormal periods such as the 1998 financial crisis and it is possible that this provides a misleading estimate of future values.

A simple test of whether the current yields should be considered as 'abnormal' is to compare current with historic rates. Table 4.12 shows the current return on the 10 year HKMA bond as 7.61% while the average for the period 1996-2000 is 7.80%. The current rate is therefore approximately in line with historic rates.

We have therefore used the current yield on the 10year HKMA bond (7.61%) as the risk-free rate for this estimation of the cost of capital with respect to the local market.

4.1.3.2 World risk-free rate

The world risk-free rate is usually taken as the risk-free rate in the USA where the appropriate figure to use for the risk free rate appears to be the most contentious issue in applying the CAPM to regulated industries. In practice, there are a variety of risk free rates from which to choose. A comparison of the nominal yields of a one year US Treasury note and a 30 year Treasury note produces a range between 3.30% and 6.83%. The current[6] yield on 10 year Treasury notes in the US is 4.01%

In the UK, the debate over the choice of risk free rate is not so contentious. It is now generally accepted that the best proxy for a true risk free rate is the current yield on index linked gilts.

Although there are debates over the appropriate maturity of the index linked gilt, the yields of UK index gilts are not so sensitive to the value that is chosen. Ofgas, for example, recently proposed a range of 3.5%-3.8% (real) on the basis that this is the redemption yield of gilts with maturities within the price control of five years. British Gas, in response, claimed that the risk free rate was 4.5% (real) arguing that the maturities chosen should match the asset lives rather than the regulatory period.[7]

For the sake of consistency with our calculation of the Hong Kong risk-free rate, we have chosen the current US 10-year treasury bill yield of 4.01% as the world risk-free rate. As we would expect, this is significantly lower than our estimate of the Hong Kong risk-free rate reflecting the inflation and country risk associated with Hong Kong.

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6 5 May 2000

7 See, 1997 Price Control Review Transportation and Storage - British Gas' Response to the Director General's Initial Proposals. June 1996

5 ANALYSIS - THE COST OF DEBT

5.1 Estimating the Cost of Debt

The cost of debt can be expressed as the sum of the risk free rate and the company specific debt premium. The company specific debt premium is driven by actual (or implied) credit ratings based on financial characteristics such as market capitalisation, earnings volatility, and business risks specific to the company and / or the sector.

The principles set out in section 3 make it clear that the estimated debt premium for a company needs to be consistent with the assumed gearing and credit ratings. There are essentially two approaches that could be taken:

- Estimate the debt premium based on the current gearing level
- Estimate a debt premium based on an assumed "optimal" gearing level.

Sections 5.1.1 and 5.1.2 report evidence from international bond markets on the cost of corporate debt.

5.1.1 Evidence on current costs of borrowing

We have no direct evidence on the costs of borrowing of Cable & Wireless HKT (CWHKT) subsidiary companies. Evidence is available, however, on the market cost of debt for Parent Groups shown in the table below.

Table 5.1
Recent Debt Issues by Hong Kong Companies

Company	S&P Rating	Currency	Coupon	Maturity	Redemption Yield to Maturity	Spread over US TBill	Weighted Average
Hutchison Whampoa	A	USD	6.950%	2007	8.415%	136	112
		USD	7.450%	2017	8.081%	90	
		USD	7.500%	2027	8.546%	111	
Swire Pacific Fin Intl	A-	USD	8.500%	2004	8.070%	181	181
China Telecom HK	BBB	USD	7.875%	2004	8.405%	119	119
New World Development	NR	USD	4.375%	2000	9.470%	143	143

Source: Bloomberg

Table 5.1 shows that current yields for Parent companies vary between 119 and 181 basis points above US Treasury Bill yields.

5.1.2 Evidence on the costs of debt finance for "comparator" companies

Table 5.2 and Table 5.3 show spreads (in basis points) on 21 April 2000 for recent debts issued by UK and US telecom companies, as well as other variable such as coupon, maturity and yield. The table is presented such that companies with similar credit ratings are grouped together.

Table 5.2
Spreads on Recent Debt Issues by UK Telecom Companies

S&P's/ Moody's Rating	Company	Gearing	Coupon	Maturity	Yield	Spread	Mean	Spread, six months ago	Mean
AAA-AA /	British Telecom Plc	11.39%	7.125%	2003	6.765%	68	168.5	71	126.6
Aaa-Aa3	British Telecom Plc		8.625%	2020	6.447%	169		112	
	British Telecom Plc		5.750%	2028	6.362%	179		143	
A /	Cable & Wireless Int Fin	17.10%	10.375%	2002	7.008%	77	132.9	103	141.2
A1-A3	Cable And Wireless Plc		8.750%	2012	6.509%	125		140	
	Cable & Wireless Int Fin		8.625%	2019	6.270%	129		161	
	Carlton Communications	N / a	7.625%	2007	7.130%	138		118	
	Carlton Communications		5.625%	2009	7.059%	180		146	
	Vodafone Group Plc	1.14%	7.875%	2001	6.891%	61		74	
	Vodafone Group Plc		7.500%	2004	6.941%	106		116	
BBB /	Cable & Wireless Commun	18.64%	7.125%	2005	6.061	18	157.7	52	143.1
Baa1-3	Orange Plc	N / a	8.625%	2008	8.032	245		200	

Source: Barclays Capital, (14 April 2000, 26 November 1999), Weekly Bond Price Service, UK Corporate Bond Issues. Spreads are measured in basis points (0.01%). N/a = not available.

This table shows that current debt premia for C&W Plc and C&W International Finance lies around 120-130 basis points although it was higher six months ago. This evidence provides some indication of the debt premia for HKCWT were it to raise debt finance on the international markets with Parent guarantees.

Table 5.3
Spreads on Recent Debt Issues by US Telecom Companies

Company	S&P Rating	Moody's Rating	Coupon	Maturity	Yield	Spread	Weighted Average	Adjusted Weighted Average
Ameritech Cap Funding Corp	AA-	Aa3	5.650%	2001	6.280%	26.8	117.9	117.9
			6.300%	2004	7.123%	43.3		
			6.550%	2028	7.619%	131.8		
Bellsouth Telecom	AAA	Aa2	6.250%	2003	6.884%	19.4	155.2	161.8
			6.375%	2004	7.117%	42.7		
			6.375%	2004	6.946%	25.6		
			5.875%	2009	7.529%	-36.1		
			7.000%	2025	7.486%	109.7		
			6.375%	2028	7.537%	123.6		
			8.250%	2032	7.945%	182.8		
			7.875%	2032	7.894%	177.7		
			7.500%	2033	7.928%	181.1		
			6.750%	2033	7.878%	176.1		
			6.750%	2033	7.930%	181.3		
			7.625%	2035	7.987%	187.0		
Bell Atlantic - New Jersey Inc	AA-	Aa2	5.875%	2004	7.144%	45.4	49.0	49.0
			5.875%	2004	7.216%	52.6		
AT&T Corp	AA-	A1	5.625%	2004	7.239%	54.9	69.5	116.5
			5.625%	2004	7.181%	49.1		
			5.625%	2004	7.153%	46.3		
			5.625%	2004	7.214%	52.4		
			5.625%	2004	7.106%	41.6		
			7.000%	2005	6.423%	-23.9		
			6.000%	2009	7.491%	-39.9		
			6.000%	2009	7.540%	-35.0		
			6.000%	2009	7.334%	-55.6		
			6.000%	2009	7.589%	-30.1		
			6.000%	2009	7.226%	-66.4		
			6.000%	2009	7.569%	-32.1		
			6.000%	2009	7.511%	-37.9		
			8.125%	2024	7.846%	144.9		
			6.500%	2029	7.692%	140.6		
			6.500%	2029	7.596%	131.0		
			6.500%	2029	7.152%	86.6		
			6.500%	2029	7.594%	130.8		

Company	S&P Rating	Moody's Rating	Coupon	Maturity	Yield	Spread	Weighted Average	Adjusted Weighted Average
US West Communications Inc	A	A2	6.375%	2002	7.147%	52.7	191.0	191.0
			6.375%	2002	7.139%	51.9		
			5.650%	2004	7.310%	62.0		
			6.875%	2033	8.221%	210.4		
			7.250%	2025	8.062%	167.3		
			6.875%	2033	8.244%	212.7		
			7.125%	2043	8.098%	198.1		
Vodafone Airtouch Plc	A-	A2	7.625%	2005	7.519%	85.7	-1.0	85.3
			7.625%	2005	7.511%	84.9		
			7.750%	2010	7.835%	-87.4		
Sprint Corp	BBB+	Baa1	8.125%	2002	7.253%	63.3	63.3	63.3
Sprint Cap Corp	BBB+	Baa2	5.700%	2003	7.178%	48.8	59.4	59.4
			5.700%	2003	7.253%	56.3		
			5.700%	2003	7.174%	48.4		
			5.875%	2004	7.481%	79.1		
			5.875%	2004	7.274%	58.4		

Source: www.bondsonline.com

For each credit rating, the mean of the spreads is calculated weighted by the number of years to redemption. As there are a number of negative spreads, this may present a biased view. An adjusted average is therefore calculated by excluding those spreads.

Both Table 5.2 and Table 5.3 show that there is no clear relationship between credit ratings and debt spreads across the range of bond issues that are considered. This is because bond spreads also depend on a number of factors such as coupon, maturity, yield, and the presence of embedded covenants.

Perhaps, better evidence is provided by considering a wider range of debt issues for each credit rating categorised by maturity. The following table summarises such data:

Table 5.4
Spreads for Debts Issued by US Utilities

S&P Rating	1 yr	2 yr	5 yr	10 yr	30 yr
AAA	103	78	112	174	246
AA+	n/a	82	n/a	n/a	76
AA	127	78	114	142	611
AA-	122	81	113	153	222
A+	143	100	125	179	213
A	123	100	133	171	272
A-	119	111	128	185	425
BBB+	169	121	152	203	347
BBB	226	183	212	241	637
BBB-	212	146	172	239	408
BB+	214	203	266	320	301
BB	n/a	266	367	372	464
BB-	222	323	699	617	677

Source: www.bondsonline.com

S&P spreads are the weighted (by amount outstanding) average spreads of S&P rated bonds which meet the industry, remaining term (Worst redemption) and rating criteria. Putable bonds are excluded.

As additional evidence a survey by NERA of financial markets, held in December 1998, looked at what would be the average debt spreads over the period 2000 to 2005 for a UK Utility at different S&P credit ratings. Our survey showed that the average expected difference between a single A and BBB rated company in expected debt spread is roughly 50 basis points. This debt spread reflects no specific debt maturity although it could be considered reasonable that respondents would assume a medium to long term maturity consistent with current financing structures.[8]

[8] A full copy of the results of this survey is available on NERA's website www.nera.com.

5.2 Interpreting the Results

5.2.1 Implied debt premia for Cable and Wireless HKT

The US, UK and Euro bond markets provide one source of evidence for spreads on Hong Kong Telecom debt premia. Companies are also able to raise debt through bank loans - NERA has no direct evidence of differential rates on bank loans versus bond rates.

As with all markets, pricing levels change over time. Currently capital markets report that it is more expensive to issue in the US than in Sterling. The US private placement market is an alternative to bond issues. However, yields are nearly always higher than US bonds.

Hong Kong companies issuing bonds will also bear currency risk and their ability to hedge will depend on the availability of bank lines. Overall, the data presented above allow us to estimate the relationship between implied debt premia, gearing and credit ratings for CWHKT. These are reported in Table 5.5.

Table 5.5
Summary of Financial Ratios and Credit Rating Relationship

	A	**BBB**
Total Debt \Total Capital	< 25%	>25%
Costs of Borrowing 2000-2005	100-150bp	200-250bp

The costs of borrowing for shorter term debt may be lower than the figures shown in Table 5.5 and the (long run) transaction costs of issuing shorter debt are higher.

5.2.2 Implied Debt Premia for New Entrant's

Several parent companies of new entrant's into the Hong Kong Telecoms market have issued debt in the US bond market at observable rates. However, this does not provide evidence of the debt premia associated with the new entrant's business in Hong Kong. We have little evidence to show what the debt premia would be for new entrant's into an industry since most of these companies are large international and established into the market.

New entrants into an industry have a lower capacity to raise debt than established companies with assigned credit ratings and proven returns. This is the result of:

- the market application of event risk, the prospect of an unknown future event having a greater effect on a small company than a large one.
- the transaction costs (eg. legal fees, issuance costs) faced by small companies are proportionately higher than for larger companies.

As a result of this, new entrants are likely to receive lower credit ratings than incumbents, if they are smaller "stand-alone" companies. It seems unlikely that a new entrant would receive an investment grade rating (BBB or above) as a stand alone company. Table 5.4 above shows that the difference in yields between BBB and BB rated bonds is approximately 150 basis points.

Of course, new entrants may also be large stand alone companies which are already rated. It is therefore impossible to distinguish full between the cost of capital for new entrants and incumbents.

Ofwat recently estimates that the cost of borrowing for small water companies could be as much as 0.7-1.0% higher than for larger water companies. In the absence of further evidence, we therefore estimate that the debt premia for new "stand-alone" entrants may be up to 1-2% higher than for the incumbent, CWHKT, which we consider is currently implied rating of single A.

However, where the entrant is part of a larger group with access to international finance or the possibility of Parent guarantees we assume the same cost of borrowing is the same as for CWHKT.

6 GEARING

6.1 Calculation of WACC

As explained in Section 3.1, the formula for the post tax WACC is as follows:

$$\text{Post} - \text{tax WACC} = g \times r_d + (1 - g) \times r_e$$

When estimating the WACC it is important to take account of how the cost of equity and cost of debt changes as gearing changes:

6.1.1 Cost of Equity and Gearing

This report does not focus on the costs of equity finance. However, it is necessary to make a number of assumptions about HK Telecom's costs of equity changes as gearing changes in order to estimate how the WACC changes with gearing.

We use the estimates of the CAPM parameters for the world market (since debt is raised in the world market):

- A nominal risk free rate of 4.0%;
- An equity risk premium of 6.5%;
- An unlevered beta of 1.1.

In the CAPM framework, gearing affects a company's cost of equity through its beta. Equity betas are converted into unlevered betas using the standard formula.[9]

$$\beta_e = \beta_a * [\, 1 + (D/E) * (1\text{-}T)] = \beta_a * [\, 1 + g/(1\text{-}g) * (1\text{-}T)]$$

where β_e is the equity beta, β_a is the unlevered beta, D is net debt (=long term debt plus short term debt minus cash), E is market equity, and g is gearing (with g = D/D+E), T is the effective tax rate. This formula implies a positive linear relationship between equity betas and gearing.

Table 6.1 reports our conclusions on how the cost of equity changes with gearing.

[9] This is the formula that was used to calculate the unlevered betas reported in Table 4.5.

Table 6.1
Changes in Cost of Equity with Gearing*

Gearing (D/D+E)	Equity Beta for HK	Average Post Tax Cost of Equity*
0%	1.11	11.2
20%	1.36	12.8

** Assumptions used: risk free rate 4.0%, equity risk premium 6.5%, corporation tax rate 11%*

6.1.2 Cost of debt and gearing

Our analysis of the relationship between the credit ratings, debt premia and the capital structure (gearing) was presented in 5. We use this analysis to estimate the international cost of new debt finance assuming a nominal risk free rate of 4.0%.

Table 6.2 below presents estimates of new pre-tax and post tax costs of debt at 20% gearing.

Table 6.2
Summary of Relationship Between Financial Ratios, Credit Rating and New Debt Costs

	Assumptions
Credit Rating	**A**
Total Debt \Total Capital	**20%**
Assumed Costs of New Borrowing 2000-2005 above Risk Free Rate	150bp
New Pre-Tax Nominal Debt Costs	**5.5%**
New Post-Tax Nominal Debt Costs (assumed interest is tax deductible)	**5.5%**

Source: NERA estimates

6.1.3 Minimum WACC

Table 6.1 and Table 6.2 show how the cost of equity finance 2000-2005 and costs of debt finance 2000-2005 change as gearing changes. These tables are now used to derive an estimate of how the nominal post tax WACC changes as capital structure changes over the range 0-20%, on the assumption that at 20% gearing CWHKT would be raising debt finance at A rates.

Table 6.3
Relationship Between Capital Structure and WACC: Scenario 1

Gearing	Credit Rating[1]	Estimated Post Tax Cost of Debt	Estimated Post Tax Cost of Equity	Estimated Post Tax WACC
0%	-	-	11.2%	11.2%
20%	A	5.5%	12.8%	11.3%

Source: NERA estimates

What this analysis shows is that the post tax WACC increases slightly as the level of gearing rises from 0% to 20%. What drives this conclusion is the extra debt premium and equity premia that arise from a downgrading in credit ratings, and increase in gearing ratios. There is also less tax advantage to debt finance for Hong Kong companies than in other parts of the world owing to a lower corporate tax rate.

If it is possible for CWHKT to raise debt finance at less than 150bp above the risk free rate then there may be some reduction in the post tax WACC as gearing rises. It should also be noted that there is less tax advantage to debt finance for Hong Kong companies than in some other parts of the world owing to a lower corporate tax rate. Hence the impact of gearing on the cost of capital is not as significant as in some other countries.

However, the analysis is based on the crucial (but standard) assumption that investors' cost of equity does rise as gearing rises, according to a standard formula. Some analysts in the UK have recently argued that the cost of equity may not increase at all for low gearing.[10] The following table derives a post tax WACC if we assume a constant cost of equity over the gearing range 0%-20%.

Table 6.4
Relationship Between Capital Structure and WACC: Scenario 2

Gearing	Credit Rating[1]	Estimated Nominal Post Tax Cost of Debt	Estimated Nominal Post Tax Cost of Equity	Estimated Nominal Post Tax WACC
0%	-	-	11.2%	11.2
20%	A	5.5%	11.2%	10.1%

Source: NERA estimates

Under this scenario, the post tax WACC falls by 1.1% as the level of gearing rises from 0% to 20%. This scenario is based on the assumption that equity investors do not demand a higher cost of equity as gearing rises up to 20%.

[10] SBC Warburg "Cost of Capital for UK Utilities", 1997.

The actual relationship between the cost of equity and gearing of CWHKT can only be determined by empirical evidence which does not currently exist since CWHKT maintains very low gearing levels.

The standard approach to estimating the cost of capital is to assume that there is a constant positive relationship between gearing and beta –our calculations of the final cost of capital numbers in Section 9 below continue to assume this linear positive relationship. **But, as scenario 2 illustrates we recognise that it may be possible in reality for the nominal post tax WACC to be reduced significantly below 11.2% through an increase in gearing providing the credit rating did not fall below single A rating.**

This evidence is mainly based on evidence of the cost of borrowing for C&W Plc and C&W International Finance. More evidence is needed, however, on what rating CWHKT would receive were it to seek access to debt capital and how this rating would change if gearing changes.

6.2 Comments

Discussions between NERA and capital markets suggest that there are a number of reasons why a financial profile consistent with a single A credit rating in the central case would be consistent with an "optimal" or "prudent" financing policy. There are other reasons why this would be true in a market where companies require frequent access to capital for investment purposes.

- **First,** a single A credit rating will allow a utility company enough unused borrowing capacity so that during times of adversity it can use this capacity to avoid foregoing investment opportunities or reliance on rights issues that may involve high costs. In particular, it is important that financial projections under "adverse scenarios" remain consistent with investment grade status and hence continue to allow companies to finance its functions.[11]

- **Second**, spreads typically widen under adverse economic conditions as investor quality consciousness and "flight to quality" increases. Recent events in the UK bond markets, in reaction to the "Asia Crisis" offer testimony to this. Bond flotation costs, which must be borne by companies, also increase as credit ratings decline, particularly in more turbulent markets. In addition, lower rated utility bonds can be expected to carry shorter maturities which normally have higher costs.

Overall, we estimate that the optimal gearing for CWHKT would lie between 0 and 20% consistent with a credit rating of single A or above. There is little tax advantage from debt finance in Hong Kong and the evidence we have available to us suggests that telecom

[11] S&P describe a BBB rating as "Adequate" saying that "adverse economic conditions are more likely to lead to a weakened capacity of the obligator to meet its financial commitment on the obligation".

companies may experience increases in the cost of debt finance at relatively low levels of debt.

For the purposes of estimating cost of capital we have assumed a gearing of 20% for the incumbent and 35% for new entrants. This is consistent with the empirical observation that new entrants currently have a higher gearing ratio than CWHKT. We predict that, especially at this level of gearing, a "stand-alone" new entrant would be unlikely to be receive an investment grade credit rating. Hence we have assumed the cost of debt finance would be 1.5% higher for a "stand alone" new entrants than CWHKT. However, we emphasise that this is rather speculative and the Parent Structure of the new entrant would b important in determining its cost of debt finance. A small non rated new entrant may have a debt premium in excess of 2-3% (see Table 5.4 above) higher than an incumbent with an investment grade rating.

7 TAX

7.1 Introduction

One of the decisions that a regulator has to make is whether a company's cost of capital should be determined on a pre-tax or post-tax basis.

The post-tax cost of capital is the value calculated on the basis of the market return to debt and equity. This is therefore the return that is required to persuade an investor to invest in a project or company. This is not the same as the amount of profit that a project or company has to make in order to provide that rate of return.

The difference is due to the tax that a company pays. Taxes are levied on a company's profits therefore, if there is a positive tax rate, a company must have a higher rate of return on its assets than the investors require in order to be able to provide sufficient post-tax returns.

The difference between the pre-tax and post-tax cost of capital is influenced by a country's tax system in three different ways – the effect of tax on returns to debt, the effect of tax on returns to equity and the detailed provisions of the tax system for capital allowances, investment credits, depreciation schedules etc.

The pre-tax approach focuses on "scaling-up" the post-tax rate of return to a pre-tax rate of return. Various conversion formulas are used to try and reconcile pre- and post- tax WACC formulations. Normally these calculations make certain assumptions about, for example, the dividend payout ration and the extent of any tax allowances. However, none of the conversion formulae commonly proposed is complex enough to account for all of the effects. Issues of timing are also frequently ignored, as this approach attempts to approximate the tax position of the company in long run equilibrium. There is, therefore, a trade-off between the complexity of the formula and its degree of accuracy in accounting for the full impact of taxation on the return earned.

If the WACC is set on a post-tax basis, this seemingly avoids the need for a complex conversion formula. In this case, however, taxation costs need to be directly incorporated in allowed revenue, as an additional operating cost. Tax costs can be estimated using a financial model of expected cashflows. However, as noted above, the income taxes paid by a company will be a function of the allowed rate of return and the asset base. In a real, RPI-linked regulatory system, projections of the cost of tax require an assumption on the expected rate of inflation, and the cashflows allowed to cover the cost of tax then need to be deflated by the expected inflation rate.

Neither the pre-tax nor the post-tax WACC formulations therefore avoids the need for regulators to consider the financing and taxation structures of the business, in order to derive an unbiased estimate of the cost of tax.

7.2 Key Issues

7.2.1 Tax on interest payments

In most countries, a company's interest payments are tax-deductible. This means that they can be deducted from the company's pre-tax operating profits and therefore they reduce the company's tax liability

However, if interest payments are not tax-deductible, then the pre-tax returns have to be adjusted downwards in order to calculate the post-tax return. This is done according to the following formula:

$$r_d = C_d \times (1 - t_c)$$

where:

r_d is the post-tax return on debt

C_d is the pre-tax return on debt

t_c is the rate of corporation tax

In practice, the formula is usually used to convert post-tax return on debt to a pre-tax return. This is done by rearranging the formula in the following way:

$$C_d = \frac{r_d}{(1 - t_c)}$$

7.2.2 Tax on dividends

Incorporating the effect of tax on returns to equity is more complicated. There are many different kinds of system for the taxation of returns to equity. However, broadly speaking, these divide into two categories.

7.2.2.1 Classical approach

Under the classical approach to taxation, payments to investors are treated like any other income which is liable for income tax. In this case the post-tax return on equities is calculated according to the following formula:

$$r_e = C_e \times (1 - t_c)$$

where:

r_e is the post-tax return on equity

C_e is the pre-tax return on equity

7.2.2.2 Imputation approach

The main alternative to the classical approach is known as an "imputation" system under which, investors can count dividend incomes against their other taxable income. The objective of this system is to avoid the double-taxation of company profits (i.e. once through corporation tax and again through income tax). In the case the post-tax cost of equity is calculated according to the following formula:

$$r_e = C_e \times \frac{(1-t_c)}{(1-t_i)}$$

where t_i is the dividend tax credit rate.

7.2.3 Capital allowances

The tax system also has an effect on the cost of capital through other benefits such as capital and accelerated depreciation.

Under a tax system which includes an accelerated depreciation scheme, companies are allowed to depreciate new assets faster than under the regulatory regime, either as a result of shorter assumed asset lives, or a steeper depreciation profile than the standard straight-line profile typically adopted by regulators. In the absence of inflation, higher depreciation payments in the early years result in a reduction in the business' taxable profit and therefore the level of taxes paid. The effective rate of taxation (i.e. the tax paid divided by the total pre-tax profits) will therefore be lower than the statutory rate.

Where the regulator has set the allowed post-tax rate of return on the basis of the statutory rate, the rate of return actually earned by the business during the early years of an asset's life will therefore be greater, since the businesses tax payments are less.

Conversely, towards the end of an asset's life, the depreciation allowed for taxation purposes will be lower than that allowed for regulatory purposes. Taxable profit will therefore be higher than regulatory profit, and the effective rate of tax paid will exceed the statutory rate, lowering the achieved post-tax rate of return. This effect is known as the "S-curve" effect, and is common to virtually all regulatory regimes, irrespective of whether they use a real or a nominal rate of return.

This issue has an impact on the calculation of different effective tax-rates for the incumbent and new entrants for the following reason:

It would be reasonable to expect an incumbent to have a stock of assets with a wide variety of ages, ranging from those which have been newly acquired to those which are older and therefore fully-depreciated. The tax benefits of accelerated depreciation on new investment would therefore be balanced by the increased tax arising from assets having been subject to accelerated depreciation. However, a new entrant would be investing heavily in new capital assets therefore they would benefit from the effects of accelerated depreciation and face a lower effective rate of taxation.

7.2.4 Loss carry forwards

Companies are only required to pay tax on operating profits. This means that a company that does not make an operating profit does not have to pay any taxes. This is more likely to be the case for new entrants than for the incumbent operator. Therefore the effective tax rate for entrants is likely to be significantly lower than for the incumbent. This is also likely to be the case for a number of years after the entrant starts operating. In this situation, the effect of tax on incumbent and new entrant operators will be quite different.

7.3 Estimating the Effective Tax-Rate

In addition to the issues discussed above, there are some other, practical issues associated with an estimation of the effective tax-rates

7.3.1 Forward-looking effective tax-rates

7.3.1.1 Incumbents

The estimate of the cost of capital is, in principle, a forward-looking estimate. The parameters used in calculating the tax adjustment should therefore be the effective tax-rate over the relevant future period. For Cable and Wireless HKT it is possible to work out their current effective tax-rate and estimate their future tax liabilities based on projections of cash-flow and capital expenditure.

7.3.1.2 Entrants

An entrant will typically have high capital expenditures and operate at a loss in the early years. This will influence there tax liability through loss-carry forwards as will the extent to which it can take advantage of capital and accelerated depreciation allowances and adjust itself to the optimal gearing etc.

It might be possible to estimate the optimal financial structure of a new entrant into the Hong Kong telecoms market which could then be used to calculate the expected tax liabilities which would be used in the cost of capital estimation.

An alternative approach would be to look at existing entrants and try to develop a general view about the actual effective tax rates faced by these companies. This could be complemented by a comparison with the financial structure of entrants in other countries.

However, there are problems with both of these approaches. In principle, the calculation of effective-tax rates should be based on a company with the optimal capital structure (i.e. one which maximises profits by minimising its tax-burden). However, it is very difficult to estimate without reference to existing companies. But existing companies may not have optimal financial structures and therefore be facing a higher tax burden than necessary. The effect of this would be push up the pre-tax cost of capital. Comparisons with other countries are also difficult because entrants' financial structures will be partly determined by the tax system in operation in that country and therefore may not be comparable with the situation in Hong Kong.

7.3.2 Inflation

In order to convert from a real post-tax cost of capital to a real pre-tax cost of capital, the effects of inflation must be taken into account since tax is levied on the nominal profits made by a company. This is done in accordance with the following formula:

$$coc_{real}^{post-tax} = (coc_{real}^{pre-tax} + I) \times (1 - t_c) - I$$

where I = inflation

t_c = effective tax rate

rearranging gives:

$$coc_{real}^{pre-tax} = \frac{(coc_{real}^{post-tax} + I)}{(1 - t_c)} - I$$

7.4 The UK Experience

The UK regulatory experience shows that the regulators have taken a wide variety of different approaches.

7.4.1 Nominal vs real WACC

All of the UK regulators have adopted a real approach to the WACC, with the exception of Oftel in the case of BT.

Prior to the 1997 review, Oftel set a nominal return for BT on a historic cost asset base.[12] In its December 1995 consultation paper, Oftel proposed a move from a historic cost basis for asset valuation to a current cost basis. Oftel formally adopted a regulatory framework based on current cost asset valuations in its 1997 determination. However, it has continued to assess and present the cost of capital on a nominal basis.

7.4.2 Pre-tax vs post-tax WACC

UK regulators have been split between the adoption of pre-tax and post tax rates of return.

7.4.2.1 Pre-tax approach: the "MMC tax adjustment"

The difference between the real pre-tax cost of capital and the real post-tax cost of capital is known in the UK as the "tax wedge". Determining the size of the tax wedge has been a contentious issues in the UK regulatory cost of capital debate.

In its 1993 inquiry into British Gas (BG), the MMC[13] set out a formal "tax wedge model".[14] The size of BG's tax wedge was estimated using the simple formula described in Section 7.2.2.2. This formula has become known in the UK as the "MMC tax adjustment".

The use of this tax adjustment formula has become quite widespread among UK regulators. The MMC applied the same tax adjustment in its price review of Scottish Hydro Electric (1995), British Airports Authorities (1996), Northern Ireland Electricity (1997), Manchester Airport (1997), British Gas (1997) and, most recently, Cellnet and Vodafone (1998).

Offer used the MMC tax adjustment in its 1994/95 price review of the Regional Electricity Companies and also in its price review of National Grid Company in 1996.

Ofgas also adopted the MMC tax adjustment formula in its price review of British Gas in 1996.

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[12] See for example Oftel, Pricing of Telecommunication Services from 1997, page 60: "In recent price determinations [..] Oftel has implicitly used a nominal pre-tax cost of capital of 15% applied to an HCA asset base".

[13] The Monopolies and Mergers Commission

[14] In its 1992 decision in relation to BT, Oftel noted the existence of the 'tax wedge' problem, and proposed a formula for a pre-tax WACC, which is algebraically equivalent to the 1993 MMC adjustment formula.

Application of the MMC formula based on the tax rates prevailing prior to July 1997 resulted in a tax adjustment of 1.194. This was calculated using the then current rates of 33% for corporation tax and 20% for ACT.[15]

In the July 1997 budget, changes to the UK tax system were announced. In particular, the rate of corporation tax was reduced, and it was announced that the ACT credit for tax exempt or corporate shareholders was to be abolished from 1 April 1999, while the credit to individual shareholders was to be reduced to 10%.[16] In the Vodaphone/Cellnet inquiry (1998), the MMC increased the tax adjustment to 1.429 based on a forward looking corporate tax rate of 30% and ACT credit rate of 0%. By setting the rate of imputation to 0%, the MMC have implicitly assumed that it is pension funds and other corporate shareholders who are the marginal investors. No account is taken of the continuing 10% ACT credit received by individual shareholders. However, the MMC note that:

> *"It is open to question whether the ACT offset against mainstream corporation tax should have been removed in full. However, as the changes are relatively recent and share price patterns have been relatively volatile it is not possible to resolve this question definitely at this stage. For the purposes of the present inquiry we must assume no offset against the main rate of tax".*[17]

7.4.2.2 Weaknesses in the MMC adjustment formula

The MMC tax adjustment formula is based on the following simplifying assumptions:

- no capital allowances (i.e. no accelerated depreciation);
- that the company is in a fully tax paying position;
- a dividend cover of 1 (i.e. a 100% payout ratio); and
- no inflation.

These simplifying assumptions have been widely acknowledged by companies, regulators and the MMC.[18] For example, in Ofgas's 1996 price control review of BG TransCo, the regulator noted that:

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15 Prior to April 1999, the UK operated a partial imputation system for the taxation of companies and their shareholders. The tax on company profits was paid in two instalments. Advance corporation tax (ACT) on dividends was payable at a rate of 20/80ths of the actual dividend paid. This tax was then deducted from the total corporation tax bill due nine months after the end of the company's accounting period.

16 July 1997 budget.

17 MMC report on Vodaphone/ Cellnet, (1998) page 66.

18 eg, MMC Decision on Scottish Hydro May 1995; MMC decision on NIE, March 1997; Ofgas 1997 Price Control Review of BG Transco, Consultation Document 1996, MMC Decision on BG plc, May 1997; OXERA, Tax and the Cost of Capital, The Utilities Journal, January 1998.

> *"[The calculation of the tax wedge] has been simplified because, in theory, the tax wedge will be company specific and will depend on the company's dividend policy and capital allowances."* [19]

In Oftel's 1997 price control review, the regulator notes that:

> *"This [MMC] adjustment is based on a number of simplifying assumptions eg, that all profits are paid out as dividends. The correct adjustment will depend on BT's cash flow profile over the forecast period, among other things."* [20]

For most of the utility companies that have been considered, the assumption that the company is in a fully tax paying position with no surplus ACT has generally been appropriate (and rarely contested).[21] The other assumptions are, however, unrepresentative of the actual situation faced by the UK utilities.

Under the UK taxation system, capital allowances (ie, allowances for accelerated depreciation) are set against actual profits in computing taxable profits.[22] Few public estimates have been made of the impact of capital allowances on the size of the tax wedge, which will vary across companies depending on the amount of capital investment being undertaken. By ignoring capital allowances, the MMC tax wedge model overstates the size of the tax wedge.

The second simplifying assumption is that the regulated utility has a dividend cover of one, which implies that all profits are taxable at the imputation tax credit rate. In practice this assumption is incorrect since most utility companies have a payout ratio of only 40%-50%, implying a dividend cover of 2-2.25. The assumption in the MMC tax adjustment that the dividend cover is equal to 1 therefore understates the size of the tax wedge.

The final simplifying assumption incorporated in the MMC tax adjustment model is that there is no inflation. The MMC tax adjustment formula is applied to the real, post-tax cost of equity in order to calculate the real pre-tax cost of equity. This is strictly incorrect, since companies pay tax on nominal profits.[23] In addition, depreciation for tax purposes is determined in relation to historical cost. Depreciation allowances can therefore only be carried forward at historical values. Both of these factors would imply an increase in the

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[19] 1997 Price Control Review British Gas' Transportation and Storage, Consultation Document, May 1996.

[20] Pricing of Telecommunications Services from 1997: Annex E: Financial Modelling", Oftel, December 1995.

[21] Surplus ACT refers to the situation where the imputation tax credit on dividends cannot be fully offset against a company's mainstream corporation tax liability.

[22] Prior to the November 1996 Budget, the capital allowance for plant and machinery (ie, the rate at which assets could be depreciated for tax purposes) was 25%. This was reduced in the 1996 Budget to 6%.

[23] The correct approach would be to add anticipated annual inflation over the period to the real post-tax cost of equity, to give a nominal post-tax cost of equity, then apply the tax adjustment to give a nominal pre-tax cost of equity and then subtract anticipated inflation to give a real pre-tax cost of equity.

size of the pre-tax cost of equity, to reflect the impact of inflation. On the other hand, interest deductions are set against nominal debt payments.[24] Taking account of inflation may therefore decrease the cost of debt. The overall impact on the pre-tax WACC will depend on the level of gearing.

Prior to the change in capital allowances and the abolition of the imputation system, it was argued that the impact of the above assumptions largely cancelled each other out. However, the changes to the tax system mean that companies and other commentators have argued that the MMC tax adjustment formula is no longer appropriate.

However, as noted above, the MMC has continued to apply the same tax adjustment formula in its recent decision on Cellnet and Vodaphone (1998).

7.4.2.3 Pre-tax approach: Ofwat's model

In the lead up to the 1994 water industry price review, Ofwat put forward a more complex tax wedge model that takes account of capital allowances, inflation and the dividend cover ratio. [25] A simplified version of this model is:

$$\text{Pre-tax cost of equity} = (\text{post-tax cost of equity} + RPI) * (1-t_c d)*(1-t_s / DC) / (1-t_c * d) - RPI$$

where:

t_c = corporation tax rate

t_s = the rate of imputation

RPI = expected inflation

d = rate at which capital can be depreciated for tax purposes

DC = dividend cover ratio.[26]

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[24] Ofwat's 1991 tax wedge model takes into account the effect of expected inflation on interest tax shields.

[25] "Cost of Capital: A Consultation Document", Ofwat 1991. In the case of the water companies, the impact of capital allowances on the amount of taxation paid was significant, resulting in actual tax payments being much less than assumed tax payments at the statutory rate. The assumption of no capital allowances underlying the MMC adjustment formula was therefore seen as inappropriate for the water businesses.

[26] The term $t_c d$ is the rate of corporation tax multiplied by the rate at which capital can be depreciated for tax purposes (ie, the rate of capital allowances). At the time of the Ofwat consultation paper, tc was 33% whilst the rate of capital allowances was 25%. Hence, tcd was calculated as 8.3%. The problem with this formula is that it only applies to one year. For example, if companies spend $100 in year 1, the capital allowances in year 1 are 25% * $100 = $25. In year 2, capital allowances are 25% of the reminder, ie $75. The dynamic path of capital allowances is not therefore captured by the above formula.

Considerable debate ensued between Ofwat and the water industry about the inputs in the Ofwat tax wedge model and in particular the appropriate assumptions about dividend cover and assumptions about gearing.[27]

The debate over the Ofwat tax wedge model was never really resolved and in the end Ofwat did not use the model in its 1994 review.

Recent changes in the UK tax system have led some commentators to argue that Ofwat's tax wedge model should be used instead of the MMC tax adjustment formula to estimate the tax wedge.[28]

7.4.2.4 Post-tax approach

Ofwat, Oftel and the Office of the Rail Regulator have all set the cost of capital on a post tax basis.[29] (Offer also made a submission to the MMC in the Scottish Hydro Electric (1995) case to the effect that attention should focus on the post tax rate of return; however, this was not followed by the MMC in its final recommendation. [30])

As noted above, in its 1994 review, Ofwat decided against using its conversion formula for setting prices, and instead estimated the cost of capital on a post tax basis. This post-tax return was then grossed up to a pre-tax WACC by allowing a (small) percentage mark-up, common across all companies, to reflect the impact of taxation. The percentage mark-up was estimated on the basis of company specific financial modelling of expected revenue flows over the next five years.[31]

Following consultation, Ofwat has decided to retain the post-tax approach to the cost of capital for its 1999 periodic review. It noted that:

> *"most respondents did not express a strong preference [for a pre- or post-tax approach], providing allowance is made for company specific tax positions, although some City commentators favoured a post-tax basis."*[32]

However, rather than allowing a generic percentage mark-up on the post-tax return to reflect the impact of taxation, Ofwat intends to estimate the tax costs on an individual basis for each company from financial modelling of the company's expected cashflows over the regulatory period.

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27 Water Services Association (1991) "The Cost of Capital in the Water Industry"

28 "Tax and the Cost of Capital", The Utilities Journal, OXERA, January 1998.

29 Before 1997, Oftel set returns on a pre-tax basis.

30 Scottish Hydro-Electric plc: A report on a reference under section 12 of the Electricity Act, MMC May 1995.

31 Ofwat, *1994 Periodic Review*.

32 Ofwat, *The framework and business planning process for the 1999 periodic review*, February 1998.

In Oftel's first consultation paper for its 1997 review, Oftel presented the cost of capital on a pre-tax basis, using the MMC adjustment formula. BT argued that the assumptions underlying the MMC conversion formula were inappropriate for BT and too simplistic. Oftel agreed, and consequently adopted a post-tax rate of return in its 1997 price determination for BT.

The UK Office of the Rail Regulator (Orr) recently announced that it intends to target a post-tax cost of capital in its review of Railtrack's access charges.[33] This approach has been supported by Railtrack.

7.4.3 Estimates of the effective tax rate

As is clear from the above discussion, the tax-adjustment formula adopted by the MMC, Offer and Ofgas is based on statutory tax rates, and ignores any differences in the profile of tax payments over time (ie, through the application of accelerated depreciation). Since the statutory tax rate is likely to be greater than the effective tax rate (in a low-inflation environment), the MMC tax adjustment formula model overstates the size of the tax wedge.[34]

For its 1999 price review, Ofwat intend to estimate the rate of return on a post tax basis and include a projected tax cost element in the revenue requirement to reflect the company's specific tax position over the five year regulatory period.[35] Ofwat argue that, given the changes to the UK tax regime, and in particular the using up of capital allowances, the water companies will be faced with rising actual tax rates over the regulatory period, which will differ between companies. Ofwat's approach is therefore to model the short-run effective tax payments for each company. There will be no ex-post adjustment to reflect any differences between assumed and actual tax payments over the period

In its 1998 consultation paper Ofwat noted that individual companies' tax projections will be adjusted to take account of Ofwat's views about efficient capital structures, and through the application of yardstick adjustments in exceptional cases. This implies some 'benchmarking' of tax costs at the forthcoming price review, although it is not clear how such adjustments will be made. Orr are also intending to include a projected tax cost as part of its estimate of Railtrack's revenue requirement. Railtrack had argued for taxation to be treated as a cost pass through item, with an adjustment made at the end of the regulatory period for any difference between the projected tax costs allowed in the revenue requirement and the actual tax costs incurred. However, Orr has decided that it is not appropriate to treat tax as a pass through item, since this removes the ability of government to influence Railtrack's

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33 Office of the Rail Regulator, *The Periodic Review of Railtrack's Access Charges – Third Paper*, December 1998.

34 As explained in Section 0, the overstating of the tax wedge is likely to be most significant in a "start-up" situation, where accelerated depreciation charges for tax purposes exceeds accounting depreciation. In a "steady state" situation, it is likely to be less of a problem.

35 Ofwat, *Prospects for Prices*, consultation paper, October 1998.

behaviour through changes in taxation, in the same way that it does with other companies.[36] Orr has instead decided to incorporate a forecast of corporation tax payments in the company's required revenue, based on the regulator's own assumptions about gearing, and not to allow adjustments ex-post.

7.4.4 Summary

In the UK, the MMC, Offer and Ofgas have all adopted a real, pre-tax rate of return, based on the same simplified conversion formula. Ofwat and the Office of the Rail Regulator (Orr) estimate the cost of capital on a real, post-tax basis, and have allowed separately for the cost of tax, either as an addition to the allowed rate of return, or as an element of the cashflows used to determine the revenue requirement. Oftel is the only UK regulator to have changed its approach. In its 1992 decision Oftel determined the WACC on a nominal, pre-tax basis. In Oftel's 1997 decision it moved to a nominal, post-tax approach, following concerns about the accuracy of the conversion formula when applied to BT.

Table 7.1
Summary of Approaches Taken to WACC

WACC Formulation				Tax Rate Used	
Real	**Nominal**	**Pre-tax**	**Post-tax**	**Statutory**	**Effective**
Majority	Oftel	MMC Offer Ofgas Oftel (pre-1997)	Ofwat Oftel (post 1997) Orr	MMC Offer Ofgas	Ofwat, Orr: short run

7.5 Hong Kong

In the UK, regulators have varied in their decisions about whether to use pre-tax or post-tax rates of returns. Their decisions have been largely based on the overall regulatory framework (e.g. when the basis for regulatory accounting is current costs or historical costs) and the extent to which the simplifying assumptions underlying the post-tax and pre-tax WACC formulations fit the actual tax-paying situation of the companies involved.

7.5.1 Corporation tax

There are therefore essentially three approaches (as outlined in our report of 1998) to calculating the effective corporate tax-rate in Hong Kong:

[36] In reaching this conclusion, Orr notes that "It is [the Regulator's] view that tax is an instrument of government policy which can influence the way companies behave as well as providing a source of income for government", *The Periodic Review of Railtrack's Access Charges: The Regulator's Conclusion on the Financial Framework*, p.30, Dec 1998.

- set it at the current rate of corporation tax (16%) on the basis that this is simple and transparent;
- set it on the basis of future cash-flows for each company;
- set it on the basis of historic effective tax rates.

In the second case, a key issue which arises is the way in which capital allowances are treated. A thorough assessment of an incumbents tax-paying position and constructing a financial model in order to forecast future effective tax-rates would be required. This is complicated and beyond the scope of the current project. It also would not take into account the issue of whether Cable and Wireless HKT has the optimal financial structure. The UK experience has shown that, while it is clear that there are theoretical problems with the simple pre-tax / post-tax conversion formulas, it has proved difficult to agree on more sophisticated ways of doing it.

The third option is also vulnerable to the problem that companies may not be optimally structured. There is also the problem of new entrants since it is impossible to use the historic effective tax –rates of companies that have not yet entered the market. Entrants also differ in their liability for tax depending on whether they are part of a larger group in Hong Kong.

The effective tax rates based on the most recent published accounts of current licensees in Hong Kong are shown in Table 7.2.

Table 7.2
Effective Tax Rates

Company	Date	Effective tax rate
Hong Kong Telephone Company	Year ending 3/1999	11.3%
New World Telephone Company	Year ending 6/1999	0%
Hutchison Communications Ltd.	Year ending 12/1998	0%
New T&T Ltd.	Year ending 12/1998	0%

7.5.2 Income tax

The second step is to consider the tax-rates that investors face. As was noted in our 1998 report, tax on interest payments, dividend payments and capital gains are all zero in Hong Kong. No special adjustment for these is therefore required.

7.5.3 Effective tax rates

We have therefore decided to use an effective tax rate of 11% in our calculation of the incumbent's cost of capital and 0% for the entrants.

8 BROADBAND VS NARROWBAND

The Hong Kong telecommunications market is undergoing rapid change, as are all telecommunications markets around the world. The increasing demand for high capacity data transmission means that companies are planning and rolling out broadband networks. The provision of a wide range of broadband services, such as fast internet, video-on demand, video-conferencing etc. has changed the business profile of many of the companies that formerly were narrowband service providers. This has changed the risks associated with those companies and therefore probably affected their cost of capital.

The terms of reference of this study essentially ask two questions on this subject.

- is it desirable to calculate a separate cost of capital for broadband? and,
- is it possible?

8.1 Issues

There are five key issues:

- Defining what is meant by broadband
- Distinguishing between broadband as a separate service and broadband as part of a trend towards the convergence of services and technologies
- Understanding the regulatory objectives
- Conceptual Reasons why the Cost of Capital for broadband and narrowband services may be different
- Examination of empirical evidence

8.1.1 Definition of broadband

The term "broadband" is a generic reference used in contra-distinction to the traditional "narrowband" technology which employs "twisted copper pair" technology (switched by means of circuits) to provide analogue telephone services to the mass market. "Narrowband" technology, as its name indicates, supports a communications medium with limited bandwidth (up to 64 Kbps) primarily used for simple voice telephony and slow data-rate services such as faxes and emails.

The term "broadband" is a generic description of network infrastructure which supports a bandwidth of between 50 Mbps to 13.2 Gbps and relies on packet switching techniques so that all media (data, voice and video) are carried in the same format on the same platform. In traditional telephony terms the term "broadband" refers to a system of "one cable and many channels". In the modern context the term "broadband" is used as a catch-all phrase to

describe both the technology and the services that can be delivered using that technology including:

- 34 Mbps or more of bandwidth;
- broadband ISDN;
- 75 Ohm radio frequency technology;
- video applications;
- cable television; and
- multimedia applications.

When using the term "broadband" in the context of network technology, it encompasses a variety of transmission systems including:

- ADSL delivery of broadband capability over copper cable.
- hybrid fibre coaxial (HFC) cable TV systems (CATV networks) using digital backbones;
- broadband integrated service digital networks or B-ISDN (155-Mbps packet switched networks);
- satellite carriage and distributive services (eg: Direct PC Internet Access);
- fibre optic transmission systems to the curb (FTTC);
- fibre optic transmission systems to the home or building (or FTTB); and
- broadband wireless networks which support interactive digital communications such UMTS, LMDS and Broadband Satellite.

For the purposes of this report the term "broadband" is used to refer to networks capable of supporting high speed multi-channel, interactive communications carried in the same format. However, we emphasise that there are a broad range of technologies, each containing its own risks.

For example, some of these technologies are well established such as Fibre Networks and Hybrid Fibre Coaxial Networks and as such offer an established platform that will support the evolution to new and higher bandwidth broadband services. Other technologies such as UMTS, and Broadband Satellite are natural progressions from existing technologies and as such can ‘piggyback’ off these services to attract new subscribers Finally, some technologies such as LMDS and ADSL are relatively new to the market and have limited ability to take advantage of any economies of scope that

may exist between themselves and existing technologies. It is these unproven technologies that offer the greatest risk.

8.1.2 Convergence

This brings us to the second issue which is convergence. As the capacity to deliver high-data rates to customers increases, the separation of services into broadcast television, telephones, video etc. becomes less significant. Narrowband PSTN networks have traditionally carried symmetrical communications, predominantly two-way real time voice communication. In the long term there will be these types of services (eg: video telephony) in the broadband world.

A single broadband switched network technology would be able to deliver fast internet, telephony, videos, video-conferencing, TV interactive services etc. Therefore there is no longer any clear separation of the services. Services would no longer be disagreggated by the technology of delivery and the content, but only the content.

Although this does not describe the current situation, current changes in technology suggest that the sector is moving in this direction. If this is the case, then it would be difficult to make a distinction between broadband and narrowband businesses since the services usually associated with these terms would be delivered over the same network by the same businesses.

The issue of convergence will mean that it is less easy to distinguish between narrowband and broadband over the medium term.

8.1.3 Regulatory objectives

If interconnection rates are to be regulated to avoid the abuse of monopoly power then it is important to distinguish between broadband and narrowband businesses.

Estimating the Long-run Incremental Cost of a broadband business in order to set interconnection rates would involve estimating a cost of capital for the business. It is necessary to consider the broadband business as a stand alone business since it would be unfair if broadband customers subsidised or benefited from the same operator's narrowband business.

As far as NERA is aware, there is no precedent for the regulation of access pricing to broadband networks.

However, experience in other countries has shown that, particularly in cities, the broadband business is sufficiently profitable to allow new entrants to invest and gain significant market share in a relatively short time. In a situation where there are many competitors operating broadband networks, the role of the regulator in determining interconnection rates is less important since competition would prevent the abuse of market power from occurring.

8.1.4 Conceptual Reasons why the Cost of Capital may be Different

The fundamental issue to consider in assessing the cost of capital for broadband versus narrowband is the systematic riskiness, as measured by beta in the CAPM formula. However, in addition, it may be argued that broadband technology has associated "real options" that result from technology uncertainty that may also increase the hurdle rates required by investors.

NERA consider that there are a number of reasons why the cost of capital of broadband may differ from narrowband:

- different industry structures and competitive environments;
- untested demand for broadband services;
- unpredictable broadband technology.

8.1.4.1.1.1 Different industry structures and competitive environment

While the narrowband technology assumes a horizontal carrier-to-carrier connection with some vertical separation for resellers, the market for broadband services is likely to be structured *vertically* as follows:

- Primary Level: ownership and operation of the broadband network infrastructure and wholesale supply of capacity;
- Retail Level: retail supply of broadband services; and
- Content Level: content suppliers (video and software suppliers).

This vertical structure is important because it will have a fundamental impact on the economics of network investment and the supply of carriage services. Further, while different broadband applications have different bandwidth requirements they are all essentially *distributive* services and therefore fundamentally different to existing *communicative* telephony services.

Content services are driving the first phase of broadband development. Content services involve asymmetric communication with a heavy bias towards downstream broadband capacity demands to deliver content services from the point of origination to the customer, with minimal upstream signalling capacity for service control

Market entry to provide broadband services will become easier as the cost of investment falls and the knowledge of the type of investment required widens. A broadband service provider, as a purveyor of distributive point-to-point content services, will probably compete with point-to-multipoint content services provided through technologies such as CATV and free-to-air broadcasting.

Whilst it is clear that there will be a considerable increase in the amount of bandwidth required for both residential and business applications, it is less certain that all the companies in the market will be able to generate a return. As the cost of installing cable falls the ability for market entry increases. There is a view that bandwidth capacity will eventually become a commoditised service with little room for supernormal profits. This means that being in the broadband market does not guarantee a return and hence has considerable risk.

In the narrowband environment the sheer scale of the incumbent operators and their first mover advantage significantly down plays their riskiness.

Untested demand

The demand for narrowband services has grown gradually over a reasonably long period of time. The market for telephony itself is driven by the demand for real time point-to-point communication. That demand is also comparatively inelastic. That is, most consumers (in developed countries) would regard a fixed-line telephone connection as essential and which is not generally priced on a usage basis. The maturity of the telephony market permits a network investor to make reasonably confident projections of future demand and prices. Accordingly, telephony carriers have been able to plan their networks with a relatively high degree of certainty.

Unlike traditional telephony, the domestic demand for broadband services is highly elastic. That is, residential demand for existing broadband services, such as pay television and video-on-demand services, is very price-sensitive. The market for new interactive broadband services has not been tested commercially. Commentators have argued that the market for switched video services is severely limited because of its low high cost combined with competition from services already available on cable and video cassette recorders.[37]

Overall, whilst demand for new bandwidth will undoubtedly grow, investors face uncertainty as to the extent of this growth as well as the level of return that will be made.

Technology risks

Broadband operators who are rolling out fibre are making significant investments which require high up front capital costs. Potential investors in broadband networks have to assess whether their capacity to recoup that substantial investment (usually over periods of up to ten years) will be undermined by emerging technological solutions such as wireless

[37] A VOD service, for instance, will probably be viewed on a home television set which is likely to remain the customer premises equipment (CPE) of choice for video entertainment for the foreseeable future.. The television set is the same CPE that would be used to view video entertainment that is delivered by DBS, a CATV network, free-to-air television or a video cassette. It is not clear that consumers will regard VOD as totally distinct from existing video delivery systems.

networks. Further, as technologies like ADSL increase the capacity of the existing copper twisted pairs, narrowband access will allow the user still greater bandwidth.

By contrast with the centralised narrowband technologies, the most expensive components of a switched broadband network will be located throughout the network and close to consumers' premises. This decentralisation will add to maintenance costs and require greater protective measures against system failure.

Unpredictable technologies can also raise hurdle rates through the creation of the real options. The exact values are difficult to quantify but can be significant.

8.1.4.2 Summary

Overall we consider that there are a number of conceptual reasons why the systematic riskiness of broadband services is currently higher than narrowband services, translating into higher required rates of returns by investors. We consider empirical evidence in the next section.

8.2 Empirical Evidence

8.2.1 Evidence from the UK

The following table summarises market evidence on unlevered beta for the UK

Table 8.1
Assets betas for UK telecommunications companies

	Unlevered beta
UK companies	
BT	1.31
C & W	1.43
Kingston Communications	1.41
Colt Telecom	2.13
Energis	2.11

Source: NERA analysis

Several things are worth noting about this table.

In the UK, BT, Cable and Wireless and could be considered to be more at the Telecommunications provision end of the spectrum while, Colt Telecom and Energis could be regarded as at the broadband end of the spectrum. Kingston offers an interesting example as it plans to provide telephony and data services primarily over ADSL. However, plans for a nation-wide network are in the early stages.

The average beta for the narrowband group is 1.38 while the average beta for the broadband group is 1.74. This difference possibly reflects the difference in the nature of their businesses.

This set is a small sample and therefore not expected to be representative. However, with a bigger sample size, it might be possible to get a more robust assessment of the difference between narrowband and broadband businesses.

8.2.2 Evidence from the US

Table 8.2
Broadband betas

Company	Equity beta	Gearing	Unlevered beta
ADAPT Broadband	1.25	7.3%	1.19
ADTRAN Inc	1.1	2.1%	1.09
Metro Media Fiber Network.	1.7	6.7%	1.63
Nextlink Communications	1.7	18.9%	1.51
RealNetworks Inc	2.15	0.0%	2.15
RCN Corporation	1.6	48.7%	1.22
Teligent Inc	1.35	19.3%	1.20
America Online.	1.75	0.2%	1.75
Excite@Home	1.6	6.3%	1.54
Media One Group Inc.	1.05	13.0%	0.97
Yahoo! Inc	1.75	0.0%	1.75
Cablevision Systems Corp.	1.15	51.8%	0.86
Shaw Communications Inc..	0.8	33.6%	0.66
Univision Communications Inc.	0.95	3.9%	0.93
Comsat Corp.	0.9	33.2%	0.74
Hughes Elec. Corp	1.15	4.2%	1.12
ADC Telecomm Inc	1.5	0.2%	1.50
Qualcomm Inc	1.45	0.4%	1.45
Average	1.38		1.29
Stdev	0.36		0.40

Source: Valueline Investment Survey 1999. Gearing is calculated as total debt / market capitalisation. The tax rate used is the US corporate tax rate, currently at 35%.

Table 8.3
Narrowband betas

Company	Equity beta	Gearing	Unlevered beta
AT&T Corp	0.85	0.02%	0.85
Alltel Corp.	0.70	18.92%	0.62
Bell Atlantic	0.85	21.57%	0.75
Bellsouth	0.80	0.02%	0.80
Centurytel Inc.	0.90	41.16%	0.71
Citizens Utils. 'B'	0.65	50.92%	0.49
GTE Corp.	0.85	33.19%	0.70
Telephone & Data Sys	0.75	20.63%	0.66
US West Inc.	0.75	34.86%	0.61
World Access Inc.	1.35	49.26%	1.02
Average	0.85		0.72
Standard deviation	0.19		0.15

Source: Valueline Investment Survey 1999. Gearing is calculated as total debt / market capitalisation. The tax rate used is the US corporate tax rate, currently at 35%.

- First, the difference between the average narrowband beta and the average broadband beta is about 0.5;
- Second, the standard deviation of narrowband betas is significantly lower than the broadband betas suggesting greater homogeneity in the services and technologies of the narrowband companies;
- Third, the selected companies offer a range of services such as fibre rings by Metro Media to internet portal sites by America Online. Increasingly it is difficult to distinguish the just where an operator is focused only on the broadband pipe and where it offers content or added value services.

In the above table for broadband betas, four companies stand out as having predominantly lower betas than the average. These are:

Table 8.4
Broadband Outliers

	Equity Beta	Gearing	Unlevered beta
Cablevision Systems Corp.	1.15	51.8%	0.86
Shaw Communications Inc..	0.8	33.6%	0.66
Univision Communications Inc.	0.95	3.9%	0.93
Comsat Corp.	0.9	33.2%	0.74

This can be explained by the fact that in all cases these are companies who have been established in their respective fields for a considerable number of years and with changing technologies, have made an almost natural progression into the provision of broadband services from an already established customer base and brand image.

For example, Cable Vision Systems apart from being one of the leading providers of cable modems and high speed internet over fibre/co-axial cable is one of the major Cable TV operators on the US. The same can be said for Shaw Communications.

Comsat Corporation offers a different example. For a number of years Comsat has been primarily a provider of global satellite systems to carry narrowband voice telephony and broadcast services. More recently, a combination of rapid industry growth, the development of cost effective, broadband satellites (capable of greater than 45Mbit/sec) and the internet induced expansion of international data traffic has seen the established satellite operators expand their role in the supply of higher bandwidth internet services.

Finally, Univision Communications is the largest broadcaster of Spanish Television in the United States reaching more than 92% of Hispanic Households.. From this base it has expanded its broadcasting services to be the largest provider of Spanish - Language internet services. Its main function is now the provision of a Spanish Portal providing broadband services such as e-commerce, home banking, home shopping, entertainment and gambling.

8.3 Conclusion

Broadband access and services are revolutionising the way in which people communicate with each other and telecommunications businesses are changing rapidly. Currently NERA consider that there are a number of reasons why the cost of capital required by investors into broadband telecommunications services would be higher.

However, the evidence available to quantify the risk premium of broadband services in Hong Kong is not directly available. We have considered evidence from the UK and the US.

This evidence shows that broadband companies have betas which exhibit considerable variation while, on average, "narrowband company" betas that are much more similar.

We conclude that the appropriate risk premium for broadband services will depend very much on the exact nature of the broadband technology.

We propose:

- Most broadband services would have a beta at least 0.2 higher than the narrowband beta;
- More risky broadband services with higher technology and capex risks may have a beta around 0.6 higher than narrowband services

More analysis needs to be done on this issue over the longer term as data becomes available.

9 RESULTS

9.1 Inflation Assumptions

Since we have chosen a risk free rate based on the yield on 10 year bonds, it is appropriate to estimate the real cost of capital based on an inflation rate for the same period.

Ten year expected inflation rates are not directly observable for either the world or Hong Kong. We have taken inflation forecasts from OECD "Consensus Forecasts Global Outlook: 2000-2010". These are shown in the table below: [38]

Table 9.1
Inflation Forecasts

	2001	**2002**	**2003**	**2004**	**2005-2009**	Average
Hong Kong	2.0	2.4	3.0	2.9	2.8	2.7
World	2.8	2.7	2.6	2.6	2.6	2.6

Source: OECD Consensus Forecasts Global Outlook

9.2 Results

Our final calculations for the cost of capital for CWHKT and "New Entrants" are based on the following analysis summarised in the following sections:

- Unlevered betas for CWHKT are set out in Table 4.4, Section 4.1;
- Unlevered betas for New Entrants are calculated according to the analysis set out in Section 4.1.1.2;
- Equity Betas are derived from Unlevered betas according to the formula set out in Section 6.1.1;
- The risk free rate is estimated according to the methodology set out in Section 4.1.3;
- Tax liabilities are estimated on the basis of current effective tax rates of 11% for CWHKT and 0% for new entrants (although we note that this assumption might not be appropriate for some new entrants);
- A tax adjustment is made according to the formula set out in Section 7.3.2;

[38] As a sensitivity, we also calculated the cost of capital based on a risk free rate of 5.7% equivalent to the current yield on a 3 month HKMA bond, where short term inflation expectations set at 0%. We find that our results are insensitive to this assumption.

- The cost of debt is estimated according to the assumptions set out in Section 5.2.2;
- Gearing is chosen according to the analysis in Section 6.2;
- The nominal pre tax WACC is then calculated according to the formula set out in Section 3.1;
- The real pre tax WACC is calculated according to the formula:

  Nominal pre tax WACC=(1 + Real Pre tax WACC)(1+expected inflation)-1*

Table 9.2
Parameters Used in the Cost of Capital Estimation

	Incumbent		Entrant	
	Local market	**International market**	**Local market**	**International market**
Unlevered beta	0.89	1.11	1.07	1.33
Equity Beta	1.09	1.36	1.64	2.05
Nominal Risk-free rate	7.61%	4.01%	7.61%	4.01%
Equity premium	10.00%	6.50%	10.00%	6.50%
Nominal Post tax cost of equity	18.49%	12.83%	24.04%	17.33%
Tax adjustment	1.12	1.12	1.00	1.00
Nominal Pre Tax Cost of Equity	20.78%	14.42%	24.04%	17.33%
Debt Premium	1.50%	1.50%	3.00%	3.00%
Nominal Pre Tax Cost of Debt Finance	9.11%	5.51%	10.61%	7.01%
Tax Rate	11%	11%	0%	0%
Nominal Post Tax Cost of Debt Finance	9.11%	5.51%	10.61%	7.01%
Gearing	20%	20%	35%	35%
Expected inflation	2.70%	2.60%	2.70%	2.60%
Nominal Post-tax WACC	16.61%	11.37%	19.34%	13.72%
Real Post-tax WACC	13.55%	8.54%	16.20%	10.84%
Nominal Pre-tax WACC	18.44%	12.63%	19.34%	13.72%
Real Pre-tax WACC	**15.33%**	**9.78%**	**16.20%**	**10.84%**

Five comments can be made about the results in Table 9.2:

i. First, for ease of presentation, the estimates presented in this table are NERA's best "point estimates" based on the available evidence at June 2000. We stress that the real cost of capital for either the local market and international market will depend on the market conditions at the time.

ii. The real post tax cost of equity is significantly higher for new entrants than incumbents, a consequence of higher gearing and higher beta estimates.

iii. The real post tax cost of capital is estimated to be 2-3% higher for new entrant's than incumbents using either the local estimate or the international estimate.

iv. The real pre tax cost of capital for entrants is only slightly higher than for incumbents than new entrants.

v. The cost of capital based on the Hong Kong market is estimated to be about 50% higher than the world market.

The difference between the post-tax cost of capital for entrants and incumbents is driven by two factors – beta and tax. As one would expect, the value of beta for entrants is slightly higher than for the incumbent. This pushes up the cost of capital but is (mostly) counteracted by the effect of taxation. Because of the tax system in Hong Kong new entrants are likely to pay no tax in the early years of operations. However, the incumbent faces a significant positive effective tax rate.

A higher gearing is also assumed for the new entrant but since the new entrant is not assumed to pay tax, the gearing assumption is not important for the final real pre tax WACC that is derived.

The difference between the cost of capital with respect to the Hong Kong market and the cost of capital with respect to the world market is striking. We would expect the international cost of capital to be lower since the bigger market allows investors to diversify their risk more widely. The values of key parameters in the CAPM formula, such as the risk-free rate and the equity premium are also lower for the major world economies than for in Hong Kong.

These results raise the question of which is more appropriate measure of cost of capital for the regulator to use.

Telecommunications markets around the world are dominated by multinational companies which have access to world financial markets. Their shareholders measure their investment returns relative to alternative global investment opportunities. Hong Kong is also relatively open market place which attracts a considerable amount of foreign investment. It is therefore very unlikely that an investor in Cable and Wireless HKT or a new entrant would be totally Hong Kong based without any access to world financial markets. We therefore estimate that the cost of capital for both CWHKT and new entrants lies somewhere between the local and international estimates set out above.

Our recommendations to OFTA are that the international estimate is more relevant for CWHKT than "stand alone" new entrants. However, since it is not standard regulatory practice to base a cost of capital estimate on the world market, we are cautious about relying too heavily on the international estimate even for CWHKT in our final recommendations.

We therefore recommend that the cost of capital for CWHKT should be set in the middle of the pure local and pure international estimates set out above. **Our best estimate of the real pre tax WACC for CWHKT is 12-14%, subject to market conditions at the time.**

For new "stand alone" entrants we recommend that OFTA pay more attention to the local cost of capital estimate than the international estimate. **Our best estimate of the real pre tax WACC for new entrants is 14-16%, subject to market conditions at the time.** Small "stand alone" new entrants may have an even higher cost of capital.

9.3 Broadband Services

Our recommendations for the cost of capital for broadband services are based on the analysis presented in Section 8. Here, we argued that the appropriate risk premium for broadband services will depend very much on the exact nature of the broadband technology.

However, we proposed that, in current market conditions, broadband services are generally riskier than narrowband services owing to:

- Higher revenue risks from increased competition;
- Increased volatility of demand for broadband services;
- Increased technology risks.

As a result of these factors and examination of the empirical evidence of observed betas from the US and the UK, we predict that most broadband technologies would have an unlevered beta at least 0.2 higher than the estimated narrowband beta for the country, and that more risky broadband services may have an unlevered beta around 0.6 higher than narrowband services. On the basis of these estimates of higher betas, and the other CAPM inputs defined above, a real pre tax cost of capital for broadband services would be between 2% and 6% higher than for narrowband services.

We have not examined in detail the relative risks of all broadband technologies. However, we consider that there is an important distinction between the cost of capital for different technologies. Those technologies that are well established such as Fibre Networks and Hybrid Fibre Coaxial Networks offer an established platform that will support the evolution to new and higher bandwidth broadband services without requiring substantially higher risk premiums. Other technologies such as UMTS, and Broadband Satellite are natural progressions from existing technologies and as such can 'piggyback' off these services to attract new subscribers (perhaps associated with technologies such as LMDS and ADSL). Risk premiums for these technologies may also not be substantially higher than narrowband technologies.

By contrast, some technologies such as LMDS and ADSL are relatively new to the market and have limited ability to take advantage of any economies of scope that may exist between themselves and existing technologies. It is these unproven technologies that offer the greatest risk. For these services, where market evidence is very limited, the cost of capital is likely to be significantly higher than narrowband services.

APPENDIX A. ARITHMETIC V'S GEOMETRIC RETURNS (OR SOME OTHER VARIANT)

In an important regulatory report, Holmans (1996) summarises the arithmetic versus geometric mean controversy as follows:

> *"The arithmetic versus geometric controversy is basically about market efficiency and how one believes the stock market functions. Market efficiency implies that equity returns are serially independent (ie no mean reversion and no method of predicting future returns). In these circumstances, the correct estimator of the future market return is the long term ex post arithmetic mean (AM)."*

Holmans presents some empirical evidence (eg. Fama (1991), Scott (1991)) providing evidence of predictability and *lack o*f mean reversion of returns, which is evidence against market efficiency.

The "Efficient Markets Hypothesis" (EMH) states that stock prices reflect information. If markets are efficient then new information is reflected quickly into market prices. Conversely, if markets are inefficient information is reflected only slowly into market prices, if at all. In order to provide a more practical definition of market efficiency it is necessary to define the information structure. There are three forms of the EMH:

Weak form efficient: If stock prices are weak form efficient, then past prices contain no information about future changes and price changes are random. Kendall (1953) found that stock and commodity prices follow a random walk.[39].

Semi-strong form efficient: If prices are semi-strong form efficient then prices reflect all public information. Empirical finding is that prices do react to information contained in an annual report. The Cumulative Abnormal Returns methodology for testing for semi-strong efficiency was pioneered for Stock splits by Fama, Fisher, Jensen and Roll (1969), and for earnings announcements by Ball and Brown (1968). Other examples are Dividend/Earning announcements [Rendleman, Jones and Latane (1982)], new issue market [Ibbotson (1975)] and merger announcements [Jensen and Ruback (1983)].

Strong form efficient: If prices are strong form efficient all private information is reflected in prices. Insider trading is not profitable and the performance of mutual funds does not generate abnormal returns. Evidence is that insider trading is slightly profitable [Finnerty (1976), Muelbrouk (1992)], but performance of mutual funds [Jensen (1968), Blake, Lehman and Timmerman (1997)] found that they do not generate abnormal returns, which is consistent with strong form efficiency.

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[39] A random walk implies zero correlation between price change at t and price change at t+1.

The empirical evidence surveyed in Fama (1991) and Fama (1998) generally supports the idea that prices do seem to be weak and semi-strong efficient but that that markets are not strong form efficient (there are theoretical reasons why strong-form efficiency is unlikely - Grossman-Stiglitz(1980)). But there are some well known anomalies.

Evidence that markets are weak and semi-strong form efficient is support for the use of the arithmetic mean to estimate equity risk premia. However, Spackman (1997) argues that there is evidence of long run mean reversion that does not challenge the assumptions of the efficient market hypothesis. Spackman argues that it is the time trend rate of growth that should be used for practical purposes such as setting the rates of return in a utility industry and that this is best estimated using geometric averages of historic returns.

Even though Cooper (1994, 1999) acknowledges that there may be long term mean reversion, he argues strongly for the use of arithmetic means to estimate an equity risk premium. His argument is simply that the CAPM estimates a discount rate that is applied to an expected cash flow, where the expectation is an arithmetic one. Thus, "an arithmetic estimate of the discount rate is consistent with the procedure, not a geometric one". Similar arguments are presented by Brealey and Myers (1991, 1996), Ibbotson Associates (1993), and Litzenberger (1984), and Morin (1995).

Jenkinson (1998) argues that the appropriate procedure to estimate the equity risk premium for regulatory purposes is to compute an arithmetic average of the geometric returns for non-overlapping historic 5 yearly periods. The logic of this argument is that this statistic represents the average of historical experience over representative 5 yearly periods which is relevant since regulators are interested in a five year horizon.

Cooper and Currie (1999) argue that Jenkinson's methodology is flawed since "the transformation from a five year total return to a geometric one is a non-linear transformation. Averages of non-linear functions are not the same as non-linear functions of averages. In this context, the arithmetic average of geometric means is not the same as the geometric average of arithmetic means. It is the latter statistic that is correct here." Cooper and Currie argue that Jenkinson's procedure underestimates the equity risk premium by about 2%.

Overall, evidence about market efficiency and mean reversion remains mixed.