REVIEW OF SUBMISSIONS ON THE RISK-FREE RATE AND THE TAMRP FOR UCLL AND UBA SERVICES

13 October 2015

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CONTENTS

EXECUTIVE SUMMARY

This paper has reviewed various arguments put forward by CEG relating to the risk-free rate and the TAMRP applicable to UCLL and UBA services, and also provided an updated estimate of the TAMRP. The principal conclusions are as follows.

Firstly, use of the CAPM requires defining the period over which it is applicable and the Commission has implicitly chosen a five-year period to match the regulatory cycle. Consistent with this, the risk-free rate within the CAPM should be defined over a five-year period and a good proxy for it is the yield to maturity on five-year government bonds. The return on such bonds is virtually risk-free over a five-year period and therefore the beta over that period will also be virtually zero. Despite this, betas estimated using returns measured over shorter periods may differ significantly from zero, due to interest rate risk, but this does not undercut the merits of using the yield to maturity on such bonds as a proxy for the risk-free rate over the next five years. Furthermore, even if changes in the beta of these bonds estimated using short periods have caused the yield to maturity to rise or fall, the yield to maturity on such bonds remains a good proxy for the five-year risk-free rate. Thus, contrary to CEG's claim, there is no basis for adjusting the yields to maturity on these bonds to provide a better estimate for the risk-free rate.

Secondly, CEG presents empirical evidence of an increase in the TAMRP since the GFC. Some of this evidence comes from the IMF, which uses a very simple version of the DGM and generates estimates of the 2008-13 level of the US MRP of 3.5% and of the global average MRP of up to 4.2%; neither of these figures suggest that the current level of the TAMRP for New Zealand is above 7%. The rest of this evidence arises from work undertaken by CEG, involving a more sophisticated version of the DGM, and generating a mid 2015 estimate of the TAMRP for New Zealand of about 9%. However, I favour consideration of evidence from a variety of methods and this is addressed below.

Thirdly, CEG favours exclusive use of the DGM to estimate the TAMRP, on the grounds that it is the only methodology that is entirely forward-looking and therefore consistent with the use of the prevailing risk-free rate. However, exclusive reliance on the estimates of the TAMRP from one approach is likely to produce a less reliable estimate (higher MSE) than from averaging over the results from a range of different approaches, particularly if these estimators are uncorrelated.

Fourthly, CEG argues that, if multiple estimators are to be used, the set should be restricted to the DGM and Siegel method 2. However, these methods are positively correlated because both use the current risk-free rate. Consequently, the MSE reductions that would arise from doing so would be much smaller than using results from a larger set of methods.

Fifthly, CEG argues that the Ibbotson and Siegel method 1 are very similar in nature, only one should then be chosen, and the Ibbotson estimator is preferable because the Siegel estimator embodies the highly speculative claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation. However, whilst these two estimators have considerable overlap in that both use the historical average market returns, the point of distinction between them (the historical average long-term real risk free rate versus an improved estimate of the expected long-term real risk free rate) causes a significant difference in outcomes. Furthermore, the empirical evidence strongly supports the claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation.

Sixthly, CEG argues that the survey-based estimator does not warrant as much weight as the DGM and Siegel version 2 estimators because the number of respondents is small, because the responses are not clearly the result of very careful consideration, because the timing of the responses differs from that of the averaging period used by the Commission to determine the risk-free rate, and because such responses may not be forward-looking (because the question asks about the MRP that they are using rather than that which they expect to prevail and therefore may elicit responses that reflect the historical average). However, whilst I agree with the second of these points, all estimators have their drawbacks and this drawback of the survey results does not suggest that it is inferior to other approaches to the extent of warranting a reduction in its weight. I do not agree with the remaining points: the sample size in the latest such survey is 31, the timing difference between the survey and the averaging period used by the Commission is only a few months, and any user of an MRP understands and intends that it applies to the future and therefore the MRP used is necessarily an estimate of what will prevail.

Seventhly, in relation to my use of pre 1985 US data and post 1985 New Zealand data to estimate the average differential between the five and ten-year New Zealand risk-free rates over the period since 1931, and therefore to generate an Ibbotson type estimate of the TAMRP relative to five-year bonds, CEG argues that there is insufficient historical data on five-year risk-free rates in New Zealand to do so. However, even if the pre 1985 New Zealand differential were considerably larger than that of the US differential that is used as a proxy, this would not affect the median estimate of the TAMRP.

Eighthly, CEG argues that, even if there were no shortcoming in the data on New Zealand government five-year bond yields, Ibbotson-type estimates of the TAMRP relative to bonds of different maturities reflect historical differences in yields on bonds of different maturities and coupling these TAMRP estimates with prevailing bond yields with a different term structure to the historical average will generate internally inconsistent results. In support of this claim, CEG presents a detailed example. However, the example involves confusing a forward interest rate with an expected future rate and, once this error is corrected, there is no internally inconsistent result.

Ninthly, CEG refers to some empirical literature that concludes that excess returns relative to the short term risk-free rate are positively related to the slope of the term structure of interest rates, and therefore argues that the estimate of the TAMRP defined against the five-year risk-free rate should be raised because the current term structure of interest rates is unusually highly sloped. In particular, CEG argues that the estimate of the TAMRP relative to the five-year yield should be raised by the current term spread between five and ten year rates. However, at best, CEG's argument would involve some increment based upon the current term spread relative to the historical average rather than the current spread. Furthermore, CEG's fails to link the size of the effect detected in the empirical literature to the size of the adjustment that they propose to the five-year TAMRP. Furthermore, the empirical results cited by them do not necessarily imply anything about the TAMRP because the predictive power may simply arise from market informational inefficiency.

Tenthly, CEG argues that, if any weight is given to long-term data in estimating the TAMRP, the same weight should be applied to a long-term average risk-free rate in estimating the appropriate regulatory risk-free rate. This approach has the following limitations: it requires that each TAMRP estimator be assigned a weight that it gives to long-term data (which is not possible in some cases), it requires the determination of a historical period over which to measure the long-run average risk-free rate (for which there is no clear answer), it wrongly assumes that any estimate of the TAMRP that uses purely historical data (such as the Ibbotson estimator) is intended to estimate the long-term average TAMRP rather than the prevailing TAMRP, and it assumes without any supporting evidence that biases in the estimation of the TAMRP arising from the use of estimators that use historical average data will be offset by use of a long-term average risk-free rate.

Eleventhly, amongst the methods that I draw upon to estimate the TAMRP, CEG ranks the DGM first, Siegel version 2 second, and Ibbotson ahead of Siegel version 1. This preference ranking corresponds exactly to the ranking in the TAMRP estimates that arise from these methods, and the probability of this arising by chance is only 2.5%. Thus, CEG's ranking of the methods would appear to be driven by their outcomes rather than their inherent methods.

Finally, I have estimated the TAMRP for New Zealand relative to the five-year risk-free rate using five methods, comprising historical averaging of excess returns, correcting these returns for the 20th century inflation shock, historical averaging of real market returns coupled with the current risk free rate and expected inflation, the DGM, and the Fernandez survey. All five methods have been applied to both New Zealand and foreign data. Using New Zealand data, the estimates range from 5.9% to 8.0% with a median of 7.1%. Using foreign data, the estimates range from 5.9% to 9.0% with a median of 7.0%. So, if rounded to the nearest 0.5%, an appropriate estimate is 7%, which matches that currently used by the Commission.

1. Introduction

The Commerce Commission (2015) has recently released a further draft determination on the WACC for UCLL and UBA services, including use of a five-year risk free rate estimated from the prevailing yield on five-year New Zealand government bonds and an estimated TAMRP of 7.0% defined relative to the five-year risk-free rate. In response CEG (2015) has raised a number of arguments. This report analyses these arguments and also estimates the TAMRP.

2. Regulatory Precedent

CEG (2015, section 2.1) argues that regulatory responses to the post-GFC fall in government bond rates should and typically do involve use of a risk-free rate in excess of that prevailing, or a higher estimate of the market risk premium, or some combination. CEG also argues that the Commerce Commission has done neither. The merits of raising the estimate of the market risk premium, and using a risk-free rate in excess of the prevailing rate, are discussed in subsequent sections of CEG's paper, and therefore will be addressed at that point. Furthermore, CEG's claim that the Commerce Commission has neither raised its estimate of the TAMRP nor used a risk-free rate in excess of the prevailing rate is false; the Commerce Commission did raise its TAMRP estimate in response to the GFC, temporarily from 7% to 7.5% (Commerce Commission, 2010, paras 6.5.16 - 6.5.18). Furthermore, the 0.5% increment matches that adopted by the AER and referred to by CEG (2015, para 75).

3. Implications of Government Bond Betas for the Risk Free Rate and the TAMRP

CEG (2015, section 2.2) claims that government bond betas were positive until about 2000, and negative thereafter, and consider the implications of this for the risk-free rate and the TAMRP.[1] In support of the claim concerning bond betas, CEG presents Figure 14 using New Zealand data, and cite the IMF (2014, Figure 3.13) and Campbell et al (2013, Figure 1) using foreign data. CEG attributes changes over time in government bond yields to these betas and therefore concludes that bond yields were above the 'true' risk-free rate prior to 2000 and

[1] CEG (2015, section 2.2) also refer to unrelated analysis and arguments in the IMF (2014) concerning post GFC changes in the MRP. This material is intermixed with that concerning bond betas but is fundamentally different, and is therefore addressed in the next section of this paper.

below it since then. Consequently, the 'true' risk-free rate that prevails at the present time is above the government bond yield by about 0.8%. In addition, the historical average 'true' risk-free rate was below the historical average bond yield, and therefore 'true' historical average excess returns (equity returns net of the risk-free rate) were larger than conventionally determined, implying that Ibbotson-type estimates of the TAMRP are too low by about 0.8%. In addition, if the TAMRP is estimated by the DGM (which uses the prevailing risk-free rate at both points in the CAPM estimate of the cost of equity), the increase of 0.8% in the conventional estimate of the risk-free rate will raise the estimated cost of equity if the equity beta is less than 1.

The product of this reasoning is rather remarkable: an estimate of a risk-free rate on an 'asset' that is neither identified by CEG nor even exists. Quite apart from the curiosity of a risk free rate existing without any underlying asset, the line of argument is entirely fallacious. The Commerce Commission has invoked a single-period version of the CAPM to estimate the cost of equity (Lally, 1992; Cliffe and Marsden, 1992). This version assumes that investors choose portfolios now in accordance with the probability distribution of possible returns over the period from now until some point in the future, and the risk-free rate within the model is therefore the prevailing rate until that future point. This future point is not defined within the model and therefore any user of the model has some latitude in choosing it. Since the typical regulatory cycle is five years, this CAPM period might be chosen to match it. In this case, the risk-free asset is one whose return is certain over the next five years, and a highly suitable proxy for this in New Zealand is the current yield to maturity on five-year government bonds. Furthermore, with the CAPM period defined to be five years, the beta of any asset is defined with respect to the same period, i.e., the sensitivity of the return on the asset over a five yearly period to the return on the market portfolio over a five yearly period. Since the return over the next five years on a New Zealand government bond is essentially certain, its beta (properly defined as just described) is essentially zero. However, when estimating the betas of risky assets such as equities, it is general practice to do so using returns (on both the asset and the market portfolio) measured over much shorter periods, most typically monthly or weekly. The rationale for this is purely pragmatic; true betas change over time, and therefore one desires to estimate them using relatively recent data, with five years being common. So, if the CAPM period is five years, then the interval over which returns are measured for the purpose of estimating beta must be appreciably less than this CAPM period of five years purely in order to obtain sufficient return observations in order to estimate the beta to any acceptable degree of precision, and this leads to returns being measured over weekly or monthly intervals. Observing such pragmatic behaviour when estimating the betas of equities, one might apply the same practice to five-year government bonds. The result would be beta estimates that were typically positive or negative, leading to the conclusion that such bonds are not risk-free. However, over the relevant period of five years, such bonds are essentially risk-free and their yields to maturity are therefore highly suitable proxies for the five-year risk-free rate. By contrast, over any shorter period, such as a week or a month, such bonds are not risk free (due to interest rate risk), but this is irrelevant to their suitability as a proxy for the risk-free rate when the CAPM period is chosen to be five years.

Furthermore, the distinct question of whether the change in this estimated beta (using weekly or monthly returns) has caused the bond yield to maturity to fall is also irrelevant to the suitability of these bonds as a proxy for the risk-free rate when the CAPM period is chosen to be five years. The CAPM requires a risk-free asset and the observed rate on such an asset (or a suitable proxy) is simply inserted into the model. Nothing in this process requires that such a rate be fixed over time or that the causes of any such changes be investigated.

Remarkably, despite arguing for an uplift in the conventional estimate of the risk-free rate of 0.8% and a similar uplift in the conventional Ibbotson estimate of the TAMRP, these adjustments are never carried forwards by CEG to the rest of their paper. In particular they do not appear in CEG (2015, section 2.4). I do not know whether this is oversight or whether CEG has subsequently lost confidence in this line of argument. Lest CEG respond to this by claiming that they favour estimating the TAMRP using the DGM, and errors in estimating the risk-free rate net out here, such a claim would be irrelevant to the entries in the first two rows of CEG's Table 10. Furthermore, as CEG acknowledge, the netting out of errors in estimating the risk-free rate when using the DGM presumes that the equity beta is 1, and the Commission's estimate is instead 0.71 (Commerce Commission, 2015, Table 1).

In summary, use of the CAPM requires defining the period over which it is applicable and the Commission has implicitly chosen a five-year period to match the regulatory cycle. Consistent with this, the risk-free rate within the CAPM should be defined over a five-year period and a good proxy for it is the yield to maturity on five-year government bonds. The return on such bonds is virtually risk-free over a five-year period and therefore the beta over that period will also be virtually zero. Despite this, betas estimated using returns measured over shorter periods may differ significantly from zero, due to interest rate risk, but this does not undercut the merits of using the yield to maturity on such bonds as a proxy for the risk-free rate over the next five years. Furthermore, even if changes in the beta of these bonds estimated using short periods has caused the yield to maturity to rise or fall, the yield to maturity on such bonds remains a good proxy for the five-year risk-free rate. Thus, contrary to CEG's claim, there is no basis for adjusting the yields to maturity on these bonds to provide a better estimate for the risk-free rate.

4. Post GFC Changes in the TAMRP

CEG (2015, section 2.2) refers to the IMF (2014, Chapter 3), who argue that three factors have contributed to the recent decline in government bond rates: an increase in the supply of savings, a decrease in the demand for investment funds, and an increased aversion to equity risk. The first two factors reduce government bond rates but without changing the MRP. The third reduces government bond rates and also raises the MRP. This suggests that the MRP has risen since the GFC. Furthermore, the IMF (2014, Figure 3.3) provides estimates of the cost of capital (WACC) as well as government bond yields, both pre and post GFC, and this reveals that the estimated MRP has risen since the GFC. This implies that the TAMRP has also risen since the GFC. However, such estimates of the WACC are only as good as the methodology used to estimate them. As described in the IMF (2014, footnote 13), the cost of equity is estimated using the simplest version of the DGM (in which the expected growth rate in dividends is constant for all future periods). This is considerably less sophisticated than the three-stage DGM used by CEG, with the expected growth rate in the last stage tied into the expected growth rate in GDP, and CEG also considers results from different estimation methods. Thus, CEG's approving citation of the IMF (2014) is inconsistent with CEG's own use of a considerably more sophisticated methodology for the crucial task of estimating the cost of equity. Furthermore, I also consider that the methodology used by the IMF to estimate the cost of equity is inadequate, both because it is a one-stage DGM and because it does not draw upon estimates from other methodologies. Thus, no useful conclusions about the TAMRP can be drawn from the IMF's work.

Furthermore, whilst CEG approvingly cites the IMF (2014) on the subject of *changes* in the MRP since the GFC, it does not cite the *level* of those estimates. The IMF (2014, Figure 3.2) estimates the real ten-year US government bond yield at 0% at the latest date for these estimates (2013) whilst the contemporaneous real cost of equity is estimated at 3.5% (IMF, 2014, Figure 3.3). This implies an MRP estimate of 3.5% for the US, which implies an estimate for the TAMRP below 7%. By contrast, CEG (2015, Figure 6) approvingly cites 2013 MRP estimates for the US implied by regulatory decisions of about 7%, which implies an estimate of the TAMRP above 7%. So, CEG cherry picks parameter estimates to support its case and disregards those that do not, even from the same document.

The IMF (2014, Figure 3.3) also estimates the global real cost of capital for 2001-07 at 2.8% and 2008-13 at 1.8%, and the corresponding global real government bond rates at 2.1% and 0.4% respectively. Given that the IMF's real global cost of capital is a weighted average of the real government bond rate and the real cost of equity, and the latter is the real government bond rate plus the real MRP, it follows that

$$WACC = (R_f + MRP)(1-L) + R_f L = R_f + MRP(1-L)$$

and thus

$$MRP = \frac{WACC - R_f}{1-L}$$

The IMF (2014, footnote 14) also reports that the leverage ratios used for individual countries are either 50% (US) or 67% (for the rest), and therefore the global average leverage must be between 50% and 67%.[2] Consequently, over the period 2001-07 for which the real WACC is estimated at 2.8% and the real government bond rate at 2.1%, the implied global real MRP is between 1.4% and 2.1%. Similarly, for the 2008-13 period, the implied global real MRP is between 2.8% and 4.2%. Adjusted for the difference between the MRP and the TAMRP, these figures imply that the Commerce Commission's estimate of 7% for the TAMRP is too high both before and after the GFC, and especially so before the GFC.[3] Obviously, these are not conclusions that CEG would support. If so, it cannot credibly cite the IMF's view that the MRP has *risen* since the commencement of the GFC.

[2] No evidence is cited in support of these numbers and, judging from the IMF's statement that these values were "assumed", it does not seem that the IMF even thinks this important. This casual approach to empirical estimates further undercuts the credibility of the IMF's report.

[3] An adjustment is also required to convert a real MRP to a nominal one. However, with a low rate of inflation, the adjustment would be inconsequential.

CEG (2015, section 2.2) also argues that its own DGM-based estimates of the TAMRP show that is has risen since the GFC to 9% in mid 2015 (ibid, Figure 16). CEG (2015, para 135) adds that I have endorsed this methodology. However, this is not correct. As discussed in Lally (2014, section 6.4), I argue that "…such estimates are likely to be too high because they couple a prevailing estimate of the expected market return that is constant out to infinity with a prevailing risk free rate for only the next ten years." Furthermore, even CEG (2015, page 104) accepts that I have such reservations and presents an analysis in their Appendix C in response to them. Even more importantly, I favour estimating the TAMRP using results from a range of methodologies so as to grant some protection from the deficiencies that every such methodology suffers from. Again, CEG is well aware of this because they repeatedly refer to my estimates of the TAMRP from a variety of methods (CEG, 2015, Table 1, 3, 5, 6, 10, and 20). Consequently I do not think that any useful conclusions can be drawn about changes in the TAMRP over time from an examination of the results of only one methodology. Conclusions about the TAMRP should be drawn by examining results from a variety of estimates, as has been done in Lally (2014).

In summary, CEG presents empirical evidence of an increase in the TAMRP since the GFC. Some of it arises from the IMF, which uses a very simple version of the DGM and generates estimates of the 2008-13 level of the US MRP of 3.5% and of the global average MRP of up to 4.2%; neither of these figures suggest that the current level of the TAMRP for New Zealand is above 7%. The rest of this evidence arises from work undertaken by CEG, involving a more sophisticated version of the DGM, and generating a mid 2015 estimate of the TAMRP of about 9%. However, I favour consideration of evidence from a variety of methods and this will be dealt with later.

5. CEG's Recommended Changes in Methodology

CEG (Appendix D) favours a number of changes in the Commission's methodology for estimating the TAMRP. Firstly, CEG favours exclusive use of the DGM to estimate the TAMRP, on the grounds that it is the only methodology that is entirely forward-looking and therefore consistent with the use of the prevailing risk-free rate. However, as argued in Lally (2014, section 5), exclusive reliance on the estimates of the TAMRP from one approach is likely to produce a less reliable estimate (higher MSE) than from averaging over the results from a range of different approaches, particularly if these estimators are uncorrelated.

Furthermore, even if one of the estimators were biased, it might still warrant significant weight. CEG offers no response to this argument. Furthermore, CEG (2015, Table 20) reveals that the DGM yields the highest estimate of the TAMRP across the five methodologies considered by the Commission; the probability that this is the result of chance is only 20%.

Secondly, CEG argues that, if multiple estimators are to be used, the set should be restricted to the DGM and Siegel method 2. However, these methods are highly correlated because both use the current risk-free rate. Consequently, the MSE reductions that would arise from doing so would be much smaller than using results from the five methods considered by Lally (2014). Furthermore, CEG (2015, Table 20) reveals that the DGM and Siegel method 2 yield the two highest estimates of the TAMRP across the five methodologies considered by the Commission; the probability that this is the result of chance is only 10%.[4] Furthermore, since CEG's first preference is exclusive use of the DGM (which yields the highest result) and their implicit second preference is Siegel method 2 (which has the second highest result), the probability that this ranking of preferences is the result of chance is only 5%.[5] Such probabilities suggest that CEG's choice of methodologies is driven by the results that they deliver.

Thirdly, CEG argues that the Ibbotson and Siegel method 1 are very similar in nature, only one should then be chosen, and the Ibbotson estimator is preferable because the Siegel estimator embodies the highly speculative claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation. However, whilst these two estimators have considerable overlap in that both use the historical average market returns, the point of distinction between them (the historical average long-term real risk free rate versus an improved estimate of the expected long-term real risk free rate) causes a significant difference in outcomes. In particular the difference of 1.2% shown in CEG (2015, Table 20, first column) is 60% larger than the standard deviation of the distribution of results shown

[4] The probability that the first two preferences are the highest two is the probability that the first preference is one of the top two (2/5) multiplied by the probability that the second preference is the highest of the remaining four (1/4), which is 10%.

[5] The probability that the first preference is the highest and the second preference is the next highest is the probability that the first preference is the highest (1/5) multiplied by the probability that the second preference is the highest of the remaining four (1/4), which is 5%.

there. Similarly, human DNA has a 95% commonality with that of chimpanzees, but the 5% difference induces a huge difference in behaviour.

Furthermore, in respect of CEG's claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation, this is rebutted by an examination of the parameter values used. In particular, as shown in Lally (2014, equation (6)), the Siegel version 1 estimator is the Ibbotson estimator net of the (post-tax) difference between the average actual real risk-free rate and the estimate of the expected long-term real risk-free rate. The Siegel estimate presented there uses data from 1931-2013 and embodies an average real risk-free rate for 1931-2002 of 1.5% (Lally and Marsden, 2004, Table 2) and 2.9% for 2003-2013 (Lally, 2014, Table 2), with a time-weighted average of 1.70%. By contrast, following Lally and Marsden (2004), Lally (2014b, section 6.3) uses an estimate for the expected long-run real risk-free rate of 3.5%. These last two parameters imply that the underestimation of inflation that occurred when inflation rose dominates any overestimation that occurred when it fell. Thus, the proposition that inflation was on balance significantly underestimated over the historical period examined is not "highly speculative" as claimed by CEG but consistent with the data used to generate the Siegel estimate. A possible response to this would be to claim that the estimate for the expected long-run real risk-free rate is less than the 3.5% used by Lally (2014) and Lally and Marsden (2004), and in particular is approximately 1.7%. However, as noted in Lally (2014, section 6.3), the average real rate on inflation-protected New Zealand government bonds since their inception in 1996 has been 3.6%. In respect of earlier periods (1931-1995), in which only nominal bonds were available, there has been no long period in which inflation was stable and therefore no period in which realised real yields on these nominal bonds would be a reliable indicator of expected real yields. As argued by Lally and Marsden (2004, section 5), the best such evidence comes from 1961-65, in which inflation was comparable to that in the preceding five years, and the average real bond yield in this period was 2.4%. Further evidence comes from Australia, from the 1883-1939 period in which inflation was relatively stable and averaged 1% per year Brailsford et al (2012, Appendix); the average real yield on government bonds during this period was 3.5%. All of this suggests that the expected long-run real risk-free rate in New Zealand was well above 1.7% and was approximately 3.5%. Furthermore, in addition to (net) underestimation of inflation as an explanation for this disparity, Lally and Marsden (2004, section 5) note the presence of interest rate controls in New Zealand in the period 1972-1984, which would also have had the effect of lowering the real yield on nominal bonds.

Furthermore, on the question of whether investors did on balance underestimate inflation during the second half of the 20^{th} century, CEG cites a report by NERA (2013, pp. 21-22) that argues by reference to two US surveys of one-year ahead inflation expectations that there was no systematic tendency by US investors to underestimate or overestimate inflation (because the period up to 1980 in which inflation was underestimated was countered by the subsequent overestimation). However, the risk free rate data underlying the Siegel analysis in Lally (2014, section 6.3) is for ten years and therefore the relevant period for assessing inflation forecast errors is ten years rather than the one year used in the two surveys. Furthermore, an ability to (on average) accurately forecast inflation one year ahead would not be inconsistent with significant underestimation of inflation in ten-year forecasts. Lally (2013, section 2.12) provides an example of that type.

Furthermore, CEG's preference for the Ibbotson method over the Siegel version 2 method again involves preferring the estimator with the highest result. In conjunction with the earlier choices, which have a 5% probability of arising by chance, this new choice would have a 2.5% probability of occurring by chance.

Fourthly, CEG argues that the survey-based estimator does not warrant as much weight as the DGM and Siegel version 2 estimators because the number of respondents is small, because the responses are not clearly the result of very careful consideration, because the timing of the responses differs from that of the averaging period used by the Commission to determine the risk-free rate, and because such responses may not be forward-looking (because the question asks about the MRP that they are using rather than that which they expect to prevail and therefore may elicit responses that reflect the historical average). However, whilst the sample size in the Fernandez et al (2013, Table 2) survey cited by Lally (2014, section 6.5) was only 8, the sample size in the most recent such survey (Fernandez, 2015, Table 2) is 31 and I consider that this addresses concerns about sample size. In respect of the question of whether these survey responses are the result of very careful consideration, I agree with CEG's concerns and have previously expressed that point (Lally, 2014b, section 6.5). Nevertheless, all estimators have their drawbacks and this drawback of the Fernandez survey results does not suggest that it is inferior to other approaches to the extent of warranting a reduction in its weight. In respect of timing differences between the survey and the averaging period used by the Commission, this would only be a few months and the survey results clearly do not vary much over time. For example, the median response in 2013 was 5.8% (Fernandez et al, 2013, Table 2) whilst that for 2015 is 6.0% (Fernandez, 2015, Table 2). Thus, the timing difference is not a significant issue. Finally, in respect of the possibility that the responses are not forward-looking, because of the wording of the survey question, I consider that any user of an MRP understands and intends that it applies to the future and therefore the MRP used is necessarily an estimate what will prevail. Furthermore, even when the respondent intends that the estimate relate to the future, they might draw upon the historical evidence. In fact, it would be extraordinary if they did not and it is general practice in forecasting any parameter to draw upon historical outcomes. Thus, nothing in CEG's claims disqualifies survey estimates as forward-looking.

Fifthly, CEG objects to the method used in Lally (2014b, section 6.7) to estimate the average differential between the five and ten-year risk-free rates, involving the observed New Zealand differential for 1985-2013 (0.07%), the observed US differential for 1953-1984 (0.08%), and extrapolating the latter to the 1931-1952 period. The average differential over the entire period 1931-2014 is then 0.08%. In particular, CEG argues that there is insufficient historical data on five-year yields in New Zealand to generate an Ibbotson type estimate of the TAMRP relative to five-year bonds. However, this view contrasts with CEG's (2015, section 2.2) use of New Zealand and US data on bond betas to draw conclusions about the average New Zealand government bond beta over the period from 1931, involving New Zealand data from 1997 (Figure 14) and US data from 1960 (Figure 12). So, despite the New Zealand data and US data used by Lally (2014b, section 6.7) going back even further than that used by CEG, CEG claims that the data used by Lally is insufficient.

Furthermore, in the face of empirical deficiencies and the need to estimate a parameter, one should seek the best possible estimate and recognise its limitations. Some of these limitations are impounded into the Commission's choice of a WACC estimate that is above the 50th percentile. The limitation in question here (the interest rate differential) is not of that kind. So, one should ask whether plausible variations in the estimate would exert an effect upon the 7% estimate for the TAMRP relative to five-year bonds. For example, suppose the true differential between five and ten-year bond yields over the 1931-1984 period were four times the actual estimate of 0.08%, in which case the true differential would be 0.32%. Following the analysis in Lally (2014b, section 6.7), this would slightly raise the Ibbotson and Siegel version 1 estimates using New Zealand data but does not change the median estimate shown in Lally (2014b, Table 5, column 1). In addition, there is no impact on estimates using foreign data. So, the issue is inconsequential.

Sixthly, CEG argues that, even if there were no shortcoming in the data on New Zealand government five-year bond yields, Ibbotson-type estimates of the TAMRP relative to bonds of different maturities reflect historical differences in yields on bonds of different maturities and coupling these TAMRP estimates with prevailing bond yields with a different term structure to the historical average will generate internally inconsistent results. To illustrate this point, CEG considers a scenario in which

(a) the historical average (tax-adjusted) one-year risk-free rate is 1% less than the two-year rate, in which case the estimated TAMRP relative to one-year bonds is 1% more than that for two-year bonds (8% and 7% respectively), and
(b) the current term structure for (tax-adjusted) risk-free rates is flat at 4%, i.e., the current one and two year rates are both 4%. This implies a prevailing one-year cost of equity of 12% (4% plus 8%) and a prevailing two-year cost of equity of 11% (4% plus 7%).

CEG then claims that a current term structure for tax-adjusted risk-free rates that is flat at 4% implies that investors expect the one year rate in one year to also be 4%. Consequently, the one-year cost of equity expected in one year is 12% (4% plus 8%). Finally, CEG observes that a prevailing one year cost of equity of 12% and a one-year cost of equity expected in one year of 12% is inconsistent with a prevailing two-year cost of equity of 11%.

Clearly, the results presented in the last sentence are inconsistent, as noted by CEG. However, this internal inconsistency springs from CEG's claim that a flat term structure for tax-adjusted risk-free rates at 4% implies that investors expect the one year rate in one year to also be 4%. This claim is not correct. Letting R_{01} denote the current one-year rate and R_{02} the current two-year rate, CEG have presumably solved the following equation for the expected one-year rate in one year of 4%:

$$(1+R_{02})^2 = (1+R_{01})(1+f) \tag{1}$$

However, the parameter value f that CEG have identified in this way is not the one-year rate expected in one year $E(R_{12})$ but the forward rate, and the forward rate differs from $E(R_{12})$ by the liquidity premium L_{12} (see van Horne, 1984, Chapter 5, and equation 5-7 in particular):

$$f = E(R_{12}) + L_{12} \tag{2}$$

Substituting equation (2) into (1) and solving for L_{12} yields

$$L_{12} = \frac{(1+R_{02})^2}{1+R_{01}} - 1 - E(R_{12}) \tag{3}$$

CEG's scenario is characterised by a historical average two-year tax-adjusted risk-free rate that exceeds the average one-year rate by 1%. Equation (3) will also apply to this 'average' situation, in which $E(R_{12})$ should also approximate R_{01}. With these substitutions, the liquidity premium is approximately 2% as follows:

$$L_{12} = \frac{(1+R_{01}+.01)^2}{1+R_{01}} - 1 - R_{01} \approx .02 \tag{4}$$

Returning to CEG's prevailing scenario with $R_{01} = R_{02} = .04$, and therefore a forward rate of $f = .04$, recourse to equations (2) and (4) implies that $E(R_{12}) = .02$. The one-year cost of equity expected in one year is then

$$E(k_{12}) = E(R_{12}) + E(TAMRP_{12}) = .02 + .08 = .10 \tag{5}$$

The rationale for a liquidity premium in bonds does not apply to equities, and therefore the current two-year cost of equity k_{02} is related to the current one-year rate k_{01} and the one-year rate expected in one year $E(k_{12})$ as follows:

$$(1+k_{02})^2 = (1+k_{01})[1+E(k_{12}] \tag{6}$$

The figures given above of $E(k_{12}) = .10$ from equation (5), along with $k_{01} = .12$ and $k_{02} = .11$ given earlier by CEG, are consistent with equation (6). So, contrary to CEG's claim, there is no internal inconsistency. CEG's belief that there is arises from them confusing a forward interest rate with an expected future spot rate in equation (1).

Seventhly, CEG refers to some empirical literature that concludes that excess returns relative to the short term risk-free rate are positively related to the slope of the term structure of interest rates, and therefore argues that the estimate of the TAMRP relative to the five-year risk-free rate should be raised because the current term structure of interest rates is unusually highly sloped. In particular, CEG argues that the estimate of the TAMRP relative to the five-year yield should be raised by the current term spread between five and ten year risk-free rates. However, at best, CEG's argument would involve some increment to the five-year TAMRP based upon the current term spread relative to the historical average rather than the current spread itself. Furthermore, CEG fails to link the size of the effect detected in the empirical literature to the size of the adjustment that they propose to the five-year TAMRP. Furthermore, such empirical results do not necessarily imply anything about the TAMRP because the predictive power may simply arise from market informational inefficiency. Even Campbell and Thompson (2008, page 1511), who conclude that various predictors are useful, imply that these prediction gains are a manifestation of market inefficiency rather than changes in the MRP: "We show that…investors could have profited by using market timing strategies." Clearly one cannot *profit* from investing in equities if the MRP is expected to be higher, because the higher risk premium would simply be compensation for greater risk. So the reference to "profit" implies market informational inefficiency.

In summary, for the reasons given above, I do not support any of CEG's proposed changes in methodology.

6. BIPT Methodology

Despite favouring the DGM approach, CEG (2015, section 2.4) argues that, if any weight is given to long-term data in estimating the TAMRP (as the Commerce Commission does), the same weight should be applied to a long-term average risk-free rate in estimating the appropriate regulatory risk-free rate. For example, if the TAMRP were estimated by equally weighting the results from two methods, one of which placed 100% weight on long-term data and the other none, then the weighted average over the long-term proportions would be 50%. Thus, the appropriate estimate for the risk-free rate would involve a 50% weight on the prevailing risk-free rate and the rest on a long-term average.

This approach has the following limitations. Firstly, it requires that each estimator of the TAMRP be assigned a weight that it gives to long-term data. In respect of the Ibbotson, Siegel version 1, and DGM methods, the weights of 1, 1 and zero respectively are uncontroversial. However, the situation in respect of surveys and the Siegel version 2 is less clear. CEG (2015, Table 9) gives both a 50% long-term weight. However, surveys elicit views about the future just as the DGM does and those views are likely to be influenced by historical outcomes (as are most forecasts). Thus, if the DGM warrants a long-term weight of zero, so too should surveys. In respect of the Siegel version 2, CEG presumably gives it a long-term weight of 50% because it uses both historical and current data; this is entirely arbitrary.

Secondly, this approach requires determination of a historical period over which to measure the long-run average risk-free rate, and the appropriate choice is unclear. Prima facie, one ought to use the historical period matching that used to estimate the TAMRP when the TAMRP is estimated from historical data. However, when the risk-free rate in question is nominal, the resulting long-term average risk-free rate would be driven up by the late 20th century inflation spike. CEG chooses the period since November 2001, to match that of the Belgian regulator who proposed this approach. No justification is offered for the choice, nor is any apparent.

Thirdly, this approach assumes that any estimate of the TAMRP that uses purely historical data (such as the Ibbotson estimator) is intended to estimate the long-term average TAMRP rather than the prevailing TAMRP, and this is not necessarily so. As discussed in Lally (2014, section 5), placing some weight upon the Ibbotson estimator is desirable even when the goal is to estimate the prevailing TAMRP, because any bias that such an estimator possesses is at least partly mitigated by its imperfect correlation with other estimators, thereby reducing the Mean Squared Error (MSE) of the overall estimator of the TAMRP.

Fourthly, even if it were true that TAMRP estimators that used only historical data were valuable only in estimating the long-term average TAMRP, this approach assumes that the disparity between the long-term average TAMRP and the prevailing value matches the disparity between the current and long-term average risk-free rates, and this assumption is neither plausible nor empirically substantiated. For example, suppose the prevailing TAMRP is 8%, the long-term average was 7%, the prevailing risk-free rate is 3%, and the historical average was 6%. In addition, the long-term average TAMRP is accurately estimated using historical data and the prevailing TAMRP is accurately estimated using current data. Accordingly, the prevailing cost of equity for the market portfolio would be accurately estimated using the current risk-free rate (3%) plus the TAMRP estimate using current data (8%), which is 11%. By contrast, if a regulator uses the current risk-free rate (3%) and an estimate of the TAMRP that places equal weight on the two TAMRP estimators (7.5%), the result would be 10.5%, which would be too low by 0.5%. This is the problem referred to by CEG. However, CEG's recommended solution would be to replace the prevailing risk-free rate with an equally weighted average of the prevailing and historical average rates (3% and 6% respectively), which is 4.5%, and couple this with the regulator's equally-weighted TAMRP estimate (7.5%), which generates an estimate of the cost of equity of the market portfolio of 12.0%. So, rather than an underestimate of 0.5%, CEG's approach would yield an overestimate of 1%. Thus, the cure is worse than the disease.

Lastly, this approach assumes that the regulated business has an equity beta of 1. If this is not the case, the problem described in the last paragraph is aggravated. For example, suppose the beta is 0.71 consistent with the Commission's estimate (Commerce Commission, 2015, Table 1). In this case, the prevailing cost of equity for the regulated business would be 8.7% as follows:

$$\hat{k} = .03 + .71(.08) = .087$$

By contrast, the regulator's approach yields an estimate of 8.3% as follows:

$$\hat{k}_R = .03 + .71(.075) = .083$$

CEG's approach would yield an estimate of 9.8% as follows:

$$\hat{k}_{CEG} = .045 + .71(.075) = .098$$

So, the regulator's estimate would now be too low by only 0.4% whereas CEG's approach would yield an estimate that was too high by 1.1%. So, relative to the regulator's estimator, CEG's approach would now be even worse than before.

In summary, these limitations in the BIPT methodology are sufficiently significant that I do not recommend its use.

7. Estimating the TAMRP for Five Years

7.1 Introduction

I now seek to update the estimate for the TAMRP for five years at the present time. The Commission uses a simplified version of the Brennan-Lally CAPM (Lally, 1992; Cliffe and Marsden, 1992), which assumes (since the introduction of dividend imputation in 1988) that all dividends are fully imputed, shareholders can fully utilise the credits, the average tax rate on dividends and interest is equal to the corporate tax rate, and capital gains are tax free. Under these assumptions, the TAMRP is as follows:

$$TAMRP = E(R_m) - R_f(1 - T_c) \qquad (7)$$

where $E(R_m)$ is the expected market return exclusive of imputation credits, R_f is the risk-free rate, and T_c is the corporate tax rate. Consistent with previous analysis in Lally (2014), the results from a range of methodologies and countries are considered.

7.2 Historical Averaging of Excess Returns

I start with historical averaging of excess returns for New Zealand (the "Ibbotson" approach). Using this approach with data from 1931-2002, Lally and Marsden (2004a, Table 2) estimate the TAMRP in the general version of the Brennan-Lally model at 7.2%. Correcting for the taxation assumptions underlying the simplified version of the model that apply from 1988, the result is slightly higher at 7.3%. I apply the same approach to the years 2003-2014. For each year t, the ex-post counterpart to the TAMRP in equation (7) is

$$TA\hat{M}RP_t = R_{mt} - R_{ft}(1 - T_c) \qquad (8)$$

Consistent with Lally and Marsden (2004a), R_{ft} is the ten-year government bond rate averaged over the year with the rates taken from Reserve Bank data.[6] In respect of R_{mt}, Lally and Marsden (2004a, Appendix A) obtain this from the NZX50 Gross Index return GR_{mt} (which includes the imputation credits) as follows. Letting ICY_{mt} denote the imputation credits on the NZX50 Index return as a proportion of the equity value, D_{mt} the cash dividend yield, GD_{mt} the gross dividend yield (cash plus the imputation credits), Q_{mt} the ratio of imputation credits to cash dividends, and CR_{mt} the NZX50 Capital Index return (which excludes dividends), it follows that

$$\begin{aligned} R_{mt} &= GR_{mt} - ICY_{mt} \\ &= GR_{mt} - (GD_{mt} - D_{mt}) \\ &= GR_{mt} - \left[GD_{mt} - \frac{GD_{mt}}{1+Q_{mt}} \right] \\ &= GR_{mt} - GD_{mt}\left[1 - \frac{1}{1+Q_{mt}} \right] \\ &= GR_{mt} - (GR_{mt} - CR_{mt})\left[1 - \frac{1}{1+Q_{mt}} \right] \end{aligned}$$

Lally (2000, page 6) estimates Q_{mt} at 80% of the maximum possible rate, which is $T_c/(1-T_c)$. In addition the values for GR and CR are obtained from the New Zealand Stock Exchange.[7] The resulting value for R_m for each year is then substituted into equation (8) to yield the value for $TA\hat{M}RP$ that year. The values for these parameters and the resulting values for $TA\hat{M}RP$ are shown in Table 1 below.

Table 1: Ex-Post Values for the TAMRP 2003-2014

Year	GR	CR	T_c	Q	R_m	R_f	$TA\hat{M}RP$
2003	.253	.176	.33	.394	.231	.059	.192
2004	.251	.164	.33	.394	.226	.061	.186
2005	.100	.025	.33	.394	.079	.059	.039

[6] Table B2 on the Reserve Bank website (www.rbnz.govt.nz).

[7] The website is http://companyresearch.nzx.com/deep_ar/index.php?pageid=liveindex.

2006	.203	.145	.33	.394	.187	.058	.148
2007	-.003	-.049	.33	.394	-.016	.063	-.058
2008	-.328	-.365	.30	.343	-.337	.061	-.380
2009	.189	.124	.30	.343	.173	.055	.134
2010	.024	-.027	.30	.343	.011	.056	-.028
2011	-.010	-.060	.28	.311	-.022	.050	-.058
2012	.242	.181	.28	.311	.227	.037	.201
2013	.165	.115	.28	.311	.153	.041	.124
2014	.175	.126	.28	.311	.163	.043	.133
Average							.053

As shown in the table, the average of these ex-post values for the TAMRP is .053. This average over 12 years is combined with the estimate of .073 for 1931-2002 (72 years), to yield the updated estimate of the TAMRP of 7.0% as follows

$$TA\hat{M}RP = .073\left(\frac{72}{84}\right) + .053\left(\frac{12}{84}\right) = .070$$

This estimate of the TAMRP is defined relative to ten-year risk-free rates. Obtaining an estimate relative to the five-year risk-free rate suffers from the difficulty that five year risk-free rate data is only available in New Zealand since 1985. However, data is available on both five and ten-year rates in the US since 1953. This allows an approximation as follows. Firstly, the average differential for the New Zealand five and ten year rates from 1985-2014 inclusive has been 0.07%.[8] In addition, the average differential for the US five and ten year rates over the period 1953-1985 has been 0.08%.[9] I extrapolate the latter differential to New Zealand for the same period and also to the earlier period 1931-1953. The average differential over the entire period 1931-2014 is then 0.08%. In addition the average tax rate

[8] Data from Table B2 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz).

[9] The rates are reported at http://research.stlouisfed.org/fred2/categories/115, and average 6.42% for the five-year Treasury constant-maturity bond (GS5) and 6.50% for the Treasury ten-year constant-maturity bond (GS10).

on interest over the period since 1931 has been 0.29.[10] So, the Ibbotson type estimate for the TAMRP over the 1931-2014 period using five year risk free rates is the estimate of .07 based on ten-year rates, corrected for the rate differential (after tax) to yield .071 as follows:

$$TA\hat{M}RP = .070 + .0008(1 - .29) = .071 \tag{9}$$

In respect of other markets the same approach cannot be adopted due to lack of data on the tax parameters that are required under this approach. An alternative is to estimate the market risk premium in the standard version of the CAPM, and then adjust for the tax parameter in equation (7). Dimson et al (2015) presents estimates of the standard market risk premium in 20 foreign markets (using the ten-year risk-free rate), using data from 1900-2014.[11] With the possible exception of South Africa, they can all be regarded as 'developed' economies and therefore suitable comparators for New Zealand. The mean of these point estimates is .059 (see Table 3 below). To convert to a five-year estimate, I use the average differential between five and ten year US rates over the period 1953-2014 to proxy for the average differential in these markets over the longer period 1900-2014. The average US differential is 0.29% (data as per footnote 9), and therefore the average MRP estimate for these foreign markets based upon the five-year risk free rate is .0619. Following equation (7), and using the current New Zealand five-year risk free rate of .0274 (August 2015 average), the resulting estimate of the TAMRP is .070 as follows:

$$TA\hat{M}RP = .0619 + .0274(0.28) = .070 \tag{10}$$

In summary, the Ibbotson estimate for the TAMRP is .071 using New Zealand data and .070 using foreign data.

[10] This comprises an average of 0.28 over the pre-imputation period 1931-1987 and an average of 0.31 since (with the latter figure corresponding to the corporate tax rate in accordance with the assumptions underlying the simplified Brennan-Lally version of the CAPM used by the Commission (see section 6.1).

[11] The results presented by them use geometric differencing rather than arithmetic differencing of annual stock and bond returns. However, geometric differencing is not consistent with the definition of the market risk premium. The result from arithmetic differencing was obtained by subtracting their average bond return from their average stock return, for each market.

7.3 The Siegel Estimate

Siegel (1992) analyses real bond and equity returns in the US over the sub-periods 1802-1870, 1871-1925 and 1926-1990. He shows that the Ibbotson type estimate of the standard MRP (historical averaging of excess returns) is unusually high using data from 1926-1990, due to the very low real returns on bonds in that period. He further argues that the latter is attributable to pronounced unanticipated inflation in that period. Consequently the Ibbotson type estimate of the standard MRP is biased up when using data from 1926-1990. Thus, if the data used is primarily from that period, then this points to estimating the standard MRP by correcting the Ibbotson type estimate through adding back the historical average long-term real risk free rate and then deducting an improved estimate of the expected long-term real risk free rate. The same approach can be adopted to estimating the TAMRP, subject to correction for taxes. Applying this approach to New Zealand data, Lally and Marsden (2004b) obtain an estimate for the tax-adjusted market risk premium of .055-.062, using data from 1931-2002, with the range in values reflecting estimates of the long-run expected real risk-free rate of .03-.04. The latter estimate is consistent with the average yield on inflation-protected New Zealand government bonds since their inception in 1996, of .036.[12] Correcting these numbers, for consistency with the tax assumptions underlying the simplified version of the Brennan-Lally model used by the Commission, the result is .056-.063. I invoke the midpoint of this range, of .059.

This estimate of .059 requires augmentation by data from 2003-2014. For each year, the estimate of the Siegel-type estimate of the TAMRP is as follows:

$$TA\hat{M}RP(S)_t = TA\hat{M}RP_t + R_{ft}^r(1-T_c) - 0.035(1-T_c) \qquad (11)$$

The values for $TA\hat{M}RP$ for 2003-2014 are shown in Table 1 along with the nominal risk-free rates for those years, and are reproduced in Table 2 below. Table 2 also shows CPI inflation rates for these years[13], and this is used to convert the nominal risk-free rates for these years to real rates. Substitution into equation (11) then yields the Siegel-type estimate of the TAMRP for each year, as shown in Table 2 below.

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[12] Data from Table B2 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz).

[13] Data from Table M1 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz).

Table 2: Siegel-Type Estimates of the TAMRP 2003-2014

Year	R_f	Inf	R_f^r	$T\hat{AMRP}$	$T\hat{AMRP}(S)$
2003	.059	.016	.042	.192	.197
2004	.061	.027	.033	.186	.184
2005	.059	.032	.026	.039	.033
2006	.058	.026	.031	.148	.145
2007	.063	.032	.030	-.058	-.062
2008	.061	.034	.026	-.380	-.386
2009	.055	.020	.034	.134	.134
2010	.056	.040	.015	-.028	-.042
2011	.050	.018	.031	-.058	-.061
2012	.037	.009	.028	.201	.196
2013	.041	.016	.025	.124	.116
2014	.043	.008	.035	.133	.132
Average					.049

As shown in the table, the average of these Siegel-type estimates for the TAMRP is .049. This average over 12 years is combined with the estimate of .059 for 1931-2002 (72 years), to yield the updated Siegel-type estimate of the TAMRP of .058 as follows:

$$T\hat{AMRP} = .059\left(\frac{72}{84}\right) + .049\left(\frac{12}{84}\right) = .058 \tag{12}$$

This Siegel-type estimate of the TAMRP reflects the use of the ten-year risk-free rate, and is related to the Ibbotson estimate of the TAMRP as shown in equation (11). Changes to the two risk free rate terms in that equation (to reflect use of the five-year rates) would offset, and therefore the increment to the Siegel-type estimate of the TAMRP to reflect use of the five-year risk-free rate matches that for the Ibbotson estimate, which is shown in equation (9). So, the Siegel-type estimate of the TAMRP (version 1) using New Zealand data and the five-year risk-free rate is the estimate based upon the ten-year rate (.058) plus the adjustment to the five-year rate as shown in equation (9), yielding .059 as follows:

$$T\hat{AMRP} = .058 + .0008(1 - .29) = .059$$

In respect of other markets the same approach cannot be adopted due to lack of data on the tax parameters that are required under this approach. An alternative is to estimate the market risk premium in the standard version of the CAPM, and then adjust for the tax parameter in equation (7). Dimson et al (2015) presents estimates of the standard market risk premium in 20 foreign markets, using data from 1900-2014. For each market, I add back the average real yield on bonds and then deduct an estimate of the expected long-term real yield on bonds. Consistent with seeking to estimate the market risk premium for New Zealand, the estimate of the expected long-term real risk free rate for New Zealand should be invoked, i.e., .035. The results are shown in Table 3 and the cross-country average is .048.

Table 3: Siegel-Type Estimates of the MRP for Foreign Markets

Country	$M\hat{R}P$	$\overline{R}_f^r$	$M\hat{R}P(S)$	$\overline{R}_m^r$
Australia	.068	.025	.058	.089
Austria	.100	.049	.114	.046
Belgium	.044	.016	.025	.054
Canada	.046	.028	.039	.072
Denmark	.036	.039	.040	.072
Finland	.090	.015	.070	.093
France	.054	.011	.030	.057
Germany	.082	.013	.060	.082
Ireland	.043	.027	.035	.068
Italy	.069	.002	.036	.059
Japan	.079	.017	.061	.088
Netherlands	.052	.022	.039	.071
Norway	.050	.026	.041	.072
Portugal	.063	.025	.053	.084
South Africa	.075	.024	.064	.095
Spain	.036	.025	.026	.059
Sweden	.049	.035	.049	.080

Switzerland	.036	.027	.028	.063
UK	.050	.024	.039	.071
US	.061	.025	.051	.085
Average	.059		.048	.073

This Siegel-type estimate for the MRP of .048 reflects the use of the ten-year risk-free rate. To obtain an estimate relative to the five-year risk-free rate, it is necessary to add the average differential between the ten and five year risk-free rates. Using US data over the 1953-2014 period, this differential is 0.29% as discussed above. Thus, with this adjustment, the Siegel estimate of the MRP is .051. Converting this figure of .051 to an estimate of the TAMRP, using equation (7) and the current New Zealand five-year government stock rate of .0274 (August 2015 average), yields an estimate of .059 as follows:

$$T\hat{AMRP} = .051 + .0274(0.28) = .059 \tag{13}$$

An alternative approach to the inflation-shock issue raised by Siegel (1992, 1999) arises from Siegel's observation that the average real market return was similar across the three subperiods examined by him, leading him to conclude that the expected real market return was stable over time. Accordingly, one would estimate the expected real market return from the historical average, convert to its nominal counterpart today using a current inflation forecast, and then deduct the current risk-free rate (net of tax) in accordance with equation (7). Using data from 1900-2014, the average real market return for New Zealand was .078 (Dimson et al, 2015, Table 49). Converted to a current nominal expected market return using current expected inflation of .020 (the midpoint of the Reserve Bank's target range), the result is .0996. Substitution into equation (7) along with the current New Zealand five-year government stock rate of .0274 (August 2015 average), yields a Siegel (version 2) estimate for the TAMRP of .080 as follows:

$$T\hat{AMRP} = .0996 - .0274(1 - .28) = .080 \tag{14}$$

In respect of other markets, the natural course is to determine the cross-country average of the intertemporal average real market return. Dimson et al (2015) presents the average real market returns for 20 foreign markets, using data from 1900-2014, as shown in Table 3. As shown there, the cross-country average is .073. Converted to a current nominal expected market return for New Zealand using expected inflation of .020 (the midpoint of the Reserve Bank's target range), the result is .0945. Converted to an estimate of the TAMRP in the same way as that underlying equation (14), the result is .075 as follows:

$$\hat{TAMRP} = .0945 - .0274(1 - .28) = .075$$

Both of these versions of the Siegel approach seek to address the late 20th century inflation shock, but the first version deducts a long-term average of the expected real risk free rate whilst the second version deducts the current real risk free rate. Since the long-term average of the expected real risk free rate is .035 whilst the current real rate is lower, the first version yields a lower estimate of the TAMRP. Furthermore, since both versions seek to address the late 20th century inflation shock, they might be considered to be alternatives rather than complementary. However, the second version has merit independent of any historical inflation shock because it assumes that the expected real market return is stable over time and this may be a better assumption than that underlying the historical averaging of excess returns (that the TAMRP is stable over time). Accordingly, results from both of these versions of the Siegel approach are considered.

7.4 The DGM

A DGM is a model in which the expected market return is chosen such that it discounts future dividends on existing shares to the current market value of those shares. One version of this model (the three-stage model), which is favoured by both the AER (2013, Appendix E) and CEG (2014, section 6.3; 2015, section 2.3) involves Bloomberg's estimates of expected dividends for the first three years, followed by linear convergence over eight years from the expected growth rate in the third year to the long-run expected growth rate (applicable from year 11). Letting S_0 denote the current value of the market index, S_{11} the expected value in three years, D_t the expected dividends in year t, g the long-run expected growth rate in dividends per share (DPS) from the end of year 11, and k the market cost of equity, it follows that the current value of equities is as follows:

$$S_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + ... + \frac{D_{11}}{(1+k)^{11}} + \frac{S_{11}}{(1+k)^{11}}$$

$$= \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + ... + \frac{D_{11}}{(1+k)^{11}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{11}} \quad (15)$$

Solving (numerically) for k, and then deducting the prevailing risk free rate (net of tax), yields the estimate of the TAMRP. The expected dividends in year t constitute the cash dividends, consistent with the simplified version of the Brennan-Lally model that is used by the Commission. CEG's (2014) estimate of g is 4%, comprising expected inflation of 2% (the midpoint of the Reserve Bank's target range) and expected real growth in DPS of 2%, with the latter figure being the expected long-run real growth in GDP of 3% less a deduction of 1% for the net creation of new shares from new companies and new share issues (net of buybacks) from existing companies, i.e.,

$$g = [1 + (.03 - .01)][1.02] - 1 = .040$$

CEG's estimate for the expected long-run growth rate in New Zealand's GDP is drawn from the historical average for New Zealand since 1900. By comparison, Bernstein and Arnott (2003, Table 1) provide average real GDP growth rates over 16 other developed countries over the period 1900-2000, and these average 2.8% rising to 3.0% with exclusion of those countries that suffered devastation during wars. This provides support for CEG's estimate of 3% for New Zealand. In respect of the deduction of 1% for the net creation of new shares from new companies and new share issues (net of buybacks) from existing companies, Lally (2013, sections 7 and 8) examines this issue and concludes that an appropriate deduction would be 0.5-1.5%.

Equation (15) assumes that the dividends for year t are received at the end of year t. However, the dividends in year t would be received in a continuous stream throughout the year, with an average term till receipt of six months. Thus, following Pratt and Grabowski (2010, equation (4.14)), the AER reduces the term of discounting by six months in respect of each year. Accordingly, equation (15) becomes:

$$S_0 = \frac{D_1}{(1+k)^{0.5}} + \frac{D_2}{(1+k)^{1.5}} + \frac{D_3}{(1+k)^{2.5}} + ... + \frac{D_{11}}{(1+k)^{10.5}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{10.5}} \quad (16)$$

Finally, the AER adjusts the model if the analysis is done part way through the financial year rather than at the beginning of the year. Following Pratt and Grabowski (2010, equation (4.18)), if the analysis done at a point such that proportion y of the year remains then equation (16) becomes:[14]

$$S_0 = \frac{D_1 y}{(1+k)^{y/2}} + \frac{D_2}{(1+k)^{0.5+y}} + \frac{D_3}{(1+k)^{1.5+y}} + ... + \frac{D_{11}}{(1+k)^{9.5+y}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{9.5+y}} \quad (17)$$

As at 1 September 2015, Bloomberg's expected dividends for the NZX50 index for the calendar years 2015, 2016 and 2017 expressed as a proportion of the index value on 1 September 2015 are .0475, .0507, and .053 (implying y = 0.33 and an expected growth rate in the third year of .0454). Substitution of these parameter values into equation (17), along with g = .04, yields k = .0933. Deduction of the prevailing five-year risk free rate of .0274 (August 2015 average) net of the tax adjustment in accordance with equation (7) then yields an estimate of the TAMRP of .074 as follows:

$$T\hat{AMRP} = .0933 - .0274(1-.28) = .074 \quad (18)$$

In respect of other markets, the same model is applied to Australia. As at 1 September 2015, Bloomberg's expected dividends for the ASX200 index for the calendar years 2015, 2016 and 2017 expressed as a proportion of the index value on 1 September 2015 are .0520, .0545, and .0575 (implying y = 0.33 and an expected growth rate in the third year of .055). In addition, an appropriate estimate for the long-run expected growth rate would be g = 4.6%, comprising expected inflation of 2.5% (the midpoint of the Reserve Bank of Australia's target range) and expected real growth in DPS of 2%, with the latter figure being the expected long-run real growth in GDP of 3% less a deduction of 1% for the net creation of

[14] The AER invokes Pratt and Grabowski (2010, equation (4.18)) but this equation contains the term n instead of n-1. The test is thus: if y = 1, equation (12) must collapse to equation (11), which it does. However, Pratt and Grabowski's equation (4.18) does not then collapse to their equation (4.14).

new shares from new companies and new share issues (net of buybacks) from existing companies, i.e.,

$$g = [1+(.03-.01)][1.025]-1 = .046$$

Substitution of these parameter values into equation (17) yields k = .1042. Deduction of the prevailing Australian five-year risk free rate of .0210 (August 2015 average) net of the tax adjustment (at the Australian corporate tax rate of 30%) in accordance with equation (7) then yields an estimate of the TAMRP of .090 as follows

$$TA\hat{M}RP = .1042 - .0210(1-.30) = .0895 \tag{19}$$

This approach assumes convergence to the long-run expected growth rate in DPS over an 11 year period, and such a convergence period is at the low end of the plausible distribution. However, longer convergence periods would lead to a higher estimate of the TAMRP and therefore this approach is conservative (as noted by CEG, 2014, para 302). Furthermore, as discussed in Lally (2013), such estimates are likely to be too high because they couple a prevailing estimate of the expected market return that is constant out to infinity with a prevailing risk free rate for only the next ten years. This may or may not outweigh the impact of using a short period for convergence in the expected growth rate in DPS to the long-run rate.

7.5 Surveys

The most important characteristics of survey results are that they are recent, that they are the product of very careful consideration, and that they contain results for other markets. No available survey satisfies all three requirements but the Fernandez et al (2015) survey satisfies the first and last requirements. The survey provides estimates of the standard MRP in 41 markets including New Zealand (ibid, Table 2). This table provides both means and medians, and therefore a choice must be made. Means have the advantage of being conceptually equivalent to the sample mean returns used in determining the Ibbotson and Siegel estimates of the TAMRP, and such use of sample means is a consequence of the parameter that is estimated being a mathematical expectation. However, the survey respondents' estimates of the MRP are not returns, and therefore there is no requirement to use the mean response. Furthermore, one could reasonably suspect that some of the respondents to this survey have offered frivolous responses or responses calculated to affect the result in a particular direction because they are aware of the use of the survey results by regulators. For example, at least one Australian respondent to the 2015 survey has provided an estimate of 19% (ibid, Table 2), which is implausibly high. Even more implausible is the 25% response offered by at least one Australian respondent in 2013 (Fernandez et al, 2013, Table 2), and this one response raised the mean Australian response from 5.7% to 6.8%. In light of this problem, I have recently switched to use of the median response (Lally, 2014a, section 3) and therefore adopt the same policy here.[15] The median of the estimates of the MRP for New Zealand is .060 (from 31 responses). Adjusted in accordance with equation (7) and the prevailing five-year risk-free rate of .0274 (August 2015 average), the resulting estimate of the TAMRP is .068 as follows:

$$T\hat{AMRP} = .060 + .0274(0.28) = .068$$

Turning to the remaining 40 markets, these could be divided into 21 advanced countries (Dimson et al's 20, plus South Korea) and 19 others (which are all middle income countries). For each of these two subsets, the cross-country means of the within country medians is .055 for the 21 advanced countries and .091 for the others. Furthermore, if the within country medians are each treated as random drawings from a population, the difference in means of the two groups is statistically significant at the 99th percentile. New Zealand is clearly comparable with the first group, and I therefore invoke the cross-country median for that group, of .055. Adjusted in the usual way in accordance with equation (7), to provide an estimate of the TAMRP, the result is .063 as follows:

$$T\hat{AMRP} = .055 + .0274(0.28) = .063$$

In summary, survey data for New Zealand suggests an estimate of the TAMRP of .068 whilst that for foreign markets suggests an estimate of .063.

[15] In a recent report for the Commission (Lally, 2014b, section 6.5), I have used the mean rather than the median response. This was an oversight, but would not have affected the estimate of 7% for the TAMRP.

7.6 Overall Results

The estimates discussed above are summarised in Table 4 below. I favour use of the median result both because the DDM does not produce a point estimate in the usual sense and because use of the median reduces the impact on the estimate from an extreme outcome arising from one of the methods.

Table 4: Estimates of the TAMRP with a Five-Year Risk Free Rate

	New Zealand	Other Markets
Ibbotson estimate	7.1%	7.0%
Siegel estimate: version 1	5.9%	5.9%
Siegel estimate: version 2	8.0%	7.5%
DGM estimate	7.4%	9.0%
Surveys	6.8%	6.3%

Using only New Zealand data, the median estimate is .071. Using foreign data, the median estimate is .070. Collectively this suggests that an appropriate estimate of the TAMRP at the present time is .070, relative to the five-year risk-free rate.

8. Conclusions

This paper has reviewed various arguments put forward by CEG relating to the risk-free rate and the TAMRP applicable to UCLL and UBA services, and also provided an updated estimate of the TAMRP. The principal conclusions are as follows.

Firstly, use of the CAPM requires defining the period over which it is applicable and the Commission has implicitly chosen a five-year period to match the regulatory cycle. Consistent with this, the risk-free rate within the CAPM should be defined over a five-year period and a good proxy for it is the yield to maturity on five-year government bonds. The return on such bonds is virtually risk-free over a five-year period and therefore the beta over that period will also be virtually zero. Despite this, betas estimated using returns measured over shorter periods may differ significantly from zero, due to interest rate risk, but this does not undercut the merits of using the yield to maturity on such bonds as a proxy for the risk-free rate over the next five years. Furthermore, even if changes in the beta of these bonds estimated using short periods have caused the yield to maturity to rise or fall, the yield to maturity on such bonds remains a good proxy for the five-year risk-free rate. Thus, contrary to CEG's claim, there is no basis for adjusting the yields to maturity on these bonds to provide a better estimate for the risk-free rate.

Secondly, CEG presents empirical evidence of an increase in the TAMRP since the GFC. Some of this evidence comes from the IMF, which uses a very simple version of the DGM and generates estimates of the 2008-13 level of the US MRP of 3.5% and of the global average MRP of up to 4.2%; neither of these figures suggest that the current level of the TAMRP for New Zealand is above 7%. The rest of this evidence arises from work undertaken by CEG, involving a more sophisticated version of the DGM, and generating a mid 2015 estimate of the TAMRP for New Zealand of about 9%. However, I favour consideration of evidence from a variety of methods and this is addressed below.

Thirdly, CEG favours exclusive use of the DGM to estimate the TAMRP, on the grounds that it is the only methodology that is entirely forward-looking and therefore consistent with the use of the prevailing risk-free rate. However, exclusive reliance on the estimates of the TAMRP from one approach is likely to produce a less reliable estimate (higher MSE) than from averaging over the results from a range of different approaches, particularly if these estimators are uncorrelated.

Fourthly, CEG argues that, if multiple estimators are to be used, the set should be restricted to the DGM and Siegel method 2. However, these methods are positively correlated because both use the current risk-free rate. Consequently, the MSE reductions that would arise from doing so would be much smaller than using results from a larger set of methods.

Fifthly, CEG argues that the Ibbotson and Siegel method 1 are very similar in nature, only one should then be chosen, and the Ibbotson estimator is preferable because the Siegel estimator embodies the highly speculative claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation. However, whilst these two estimators have considerable overlap in that both use the historical average market returns, the point of distinction between them (the historical average long-term real risk free rate versus an improved estimate of the expected long-term real risk free rate) causes a significant difference in outcomes. Furthermore, the empirical evidence strongly supports the claim that underestimation of inflation during part of the historical period outweighed subsequent overestimation.

Sixthly, CEG argues that the survey-based estimator does not warrant as much weight as the DGM and Siegel version 2 estimators because the number of respondents is small, because the responses are not clearly the result of very careful consideration, because the timing of the responses differs from that of the averaging period used by the Commission to determine the risk-free rate, and because such responses may not be forward-looking (because the question asks about the MRP that they are using rather than that which they expect to prevail and therefore may elicit responses that reflect the historical average). However, whilst I agree with the second of these points, all estimators have their drawbacks and this drawback of the survey results does not suggest that it is inferior to other approaches to the extent of warranting a reduction in its weight. I do not agree with the remaining points: the sample size in the latest such survey is 31, the timing difference between the survey and the averaging period used by the Commission is only a few months, and any user of an MRP understands and intends that it applies to the future and therefore the MRP used is necessarily an estimate of what will prevail.

Seventhly, in relation to my use of pre 1985 US data and post 1985 New Zealand data to estimate the average differential between the five and ten-year New Zealand risk-free rates over the period since 1931, and therefore to generate an Ibbotson type estimate of the TAMRP relative to five-year bonds, CEG argues that there is insufficient historical data on five-year risk-free rates in New Zealand to do so. However, even if the pre 1985 New Zealand differential were considerably larger than that of the US differential that is used as a proxy, this would not affect the median estimate of the TAMRP.

Eighthly, CEG argues that, even if there were no shortcoming in the data on New Zealand government five-year bond yields, Ibbotson-type estimates of the TAMRP relative to bonds of different maturities reflect historical differences in yields on bonds of different maturities and coupling these TAMRP estimates with prevailing bond yields with a different term structure to the historical average will generate internally inconsistent results. In support of this claim, CEG presents a detailed example. However, the example involves confusing a forward interest rate with an expected future rate and, once this error is corrected, there is no internally inconsistent result.

Ninthly, CEG refers to some empirical literature that concludes that excess returns relative to the short term risk-free rate are positively related to the slope of the term structure of interest rates, and therefore argues that the estimate of the TAMRP defined against the five-year risk-free rate should be raised because the current term structure of interest rates is unusually highly sloped. In particular, CEG argues that the estimate of the TAMRP relative to the five-year yield should be raised by the current term spread between five and ten year rates. However, at best, CEG's argument would involve some increment based upon the current term spread relative to the historical average rather than the current spread. Furthermore, CEG's fails to link the size of the effect detected in the empirical literature to the size of the adjustment that they propose to the five-year TAMRP. Furthermore, the empirical results cited by them do not necessarily imply anything about the TAMRP because the predictive power may simply arise from market informational inefficiency.

Tenthly, CEG argues that, if any weight is given to long-term data in estimating the TAMRP, the same weight should be applied to a long-term average risk-free rate in estimating the appropriate regulatory risk-free rate. This approach has the following limitations: it requires that each TAMRP estimator be assigned a weight that it gives to long-term data (which is not possible in some cases), it requires the determination of a historical period over which to measure the long-run average risk-free rate (for which there is no clear answer), it wrongly assumes that any estimate of the TAMRP that uses purely historical data (such as the Ibbotson estimator) is intended to estimate the long-term average TAMRP rather than the prevailing TAMRP, and it assumes without any supporting evidence that biases in the estimation of the TAMRP arising from the use of estimators that use historical average data will be offset by use of a long-term average risk-free rate.

Eleventhly, amongst the methods that I draw upon to estimate the TAMRP, CEG ranks the DGM first, Siegel version 2 second, and Ibbotson ahead of Siegel version 1. This preference ranking corresponds exactly to the ranking in the TAMRP estimates that arise from these methods, and the probability of this arising by chance is only 2.5%. Thus, CEG's ranking of the methods would appear to be driven by their outcomes rather than their inherent methods.

Finally, I have estimated the TAMRP for New Zealand relative to the five-year risk-free rate using five methods, comprising historical averaging of excess returns, correcting these returns for the 20th century inflation shock, historical averaging of real market returns coupled with the current risk free rate and expected inflation, the DGM, and the Fernandez survey. All five methods have been applied to both New Zealand and foreign data. Using New Zealand data, the estimates range from 5.9% to 8.0% with a median of 7.1%. Using foreign data, the estimates range from 5.9% to 9.0% with a median of 7.0%. So, if rounded to the nearest 0.5%, an appropriate estimate is 7%, which matches that currently used by the Commission.

APPENDIX: TAMRPs for One and Four Years

This Appendix derives the TAMRP for a one-year period from 1 December 2014 and for a four-year period from 1 September 2015. I commence with the one-year TAMRP from 1 December 2014.

In respect of the Ibbotson estimate using New Zealand data, this is 7.0% relative to the ten-year risk-free rate using data from 1931-2014 inclusive, as derived in section 7.2. [16] Obtaining an estimate relative to the one-year risk-free rate suffers from the difficulty that one-year risk-free rate data is only available in New Zealand since 1987, and even then for only part of that period. However, data is available on both one and ten-year rates in the US since 1953. This allows an approximation as follows. Firstly, the average differential for the New Zealand one and ten year rates from 1987-2014 inclusive has been 0.09%.[17] In addition, the average differential for the US one and ten year rates over the period April 1953 – May 1987 has been 0.53%.[18] I extrapolate the latter differential to New Zealand for the same period and also to the earlier period 1931-1953. The average differential over the entire period 1931-2014 is then 0.34%. In addition, as discussed in section 7.2, the average tax rate on interest in New Zealand over the period since 1931 has been 0.29. So, the Ibbotson type estimate for the TAMRP over the 1931-2014 period using one-year risk free rates is the estimate of .070 based on ten-year rates, corrected for the rate differential (after tax) to yield .072 as follows:

$$\hat{TAMRP} = .070 + .0034(1-.29) = .072 \qquad (20)$$

In respect of other markets, and following section 7.2, I start with the cross-country average of the MRP estimates of the other 20 markets examined by Dimson et al (2015), which is .059 as shown in Table 3 above. To convert to a one-year estimate, I use the average

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[16] This estimate uses data up to the end of 2014, which is one month beyond the point in time at which the estimate is desired. This difference of one month is inconsequential.

[17] Data from Table B2 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz) and covering the 288 months from June 1987 – April 2009, August 2010 – October 2011, and February 2012 – November 2012.

[18] The rates are reported at http://research.stlouisfed.org/fred2/categories/115, and average 6.11% for the one-year Treasury constant-maturity bonds (GS1) and 6.64% for the ten-year Treasury constant-maturity bonds (GS10).

differential between one and ten year US rates over the period 1953-2014 to proxy for the average differential in these markets over the longer period 1900-2014. The average US differential is 0.97% (data as per footnote 18), and therefore the average MRP estimate for these foreign markets based upon the one-year risk free rate is .0687. Following equation (7), and using the Commerce Commission's estimate of the New Zealand one-year risk free rate at 1 December 2014 of .0362, the resulting estimate of the TAMRP is .079 as follows:

$$TA\hat{M}RP = .0687 + .0362(0.28) = .079 \tag{21}$$

In respect of the Siegel version 1 estimate, as discussed in section 7.3, the estimate of .058 reflects the use of the ten-year risk-free rate, and requires the same adjustment to yield an estimate relative to the one-year risk-free rate as shown in equation (20). The result is .060 as follows:

$$TA\hat{M}RP = .058 + .0034(1 - .29) = .060 \tag{22}$$

In respect of other markets, as discussed in section 7.3, I start with cross-country average of the Siegel estimates of the MRP defined relative to the ten-year risk-free rate of .048. To obtain an estimate relative to the one-year risk-free rate, it is necessary to add the average differential between the one and ten year risk-free rates. Using US data over the 1953-2014 period, this differential is 0.97% as discussed above. Thus, with this adjustment, the Siegel estimate of the MRP is .0577. Converting this figure of .0577 to an estimate of the TAMRP, using equation (7) and the 1 December 2014 New Zealand one-year risk-free rate of .0362, the result is an estimate of the TAMRP of .068 as follows:

$$TA\hat{M}RP = .0577 + .0362(0.28) = .068 \tag{23}$$

In respect of the Siegel version 2 estimate, and following section 7.3, I start with the estimate for the current nominal expected market return for New Zealand of .0996. Substitution into equation (7), along with the estimate for the 1 December 2014 New Zealand one-year risk-free rate of .0362, yields a Siegel (version 2) estimate for the TAMRP of .074 as follows:

$$TA\hat{M}RP = .0996 - .0362(1 - .28) = .074 \tag{24}$$

In respect of other markets, and again following section 7.3, I start with the estimate for the current nominal expected market return of .0945. Converted to an estimate of the TAMRP in the same way as that underlying equation (24), the result is .068 as follows:

$$T\hat{AMRP} = .0945 - .0362(1 - .28) = .068 \tag{25}$$

In respect of the DGM, the analysis in section 7.4 is followed. As at 1 December 2014, Bloomberg's dividend yield for the NZX50 index was .0472 and the expected dividends for the calendar years 2015, 2016 and 2017 expressed as a proportion of the index value on 1 December 2014 were .0439, .0468, and .0495 (implying y = 0.08 and an expected growth rate in the third year of .0577). Substitution of these parameter values into equation (17), along with g = .04, yields k = .0895. Deduction of the prevailing one-year risk free rate of .0362 net of the tax adjustment in accordance with equation (7) then yields an estimate of the TAMRP of .063 as follows:

$$T\hat{AMRP} = .0895 - .0362(1 - 0.28) = .063$$

In respect of other markets, following section 7.4, the same analysis is performed for Australia. As at 1 December 2014, Bloomberg's dividend yield for the ASX200 index was .0473 and the expected dividends for the calendar years 2015, 2016 and 2017 expressed as a proportion of the index value on 1 December 2014 were .0492, .0521, and .0551 (implying y = 0.08 and an expected growth rate in the third year of .0576). Substitution of these parameter values into equation (17), along with g = .046, yields k = .1000. Deduction of the prevailing Australian one-year risk free rate of .0247 (extrapolated from the November 2014 averages for the two and three-year rates of .0251 and .0255) net of the tax adjustment (at the Australian corporate tax rate of 30%) in accordance with equation (7) then yields an estimate of the TAMRP of .083 as follows:

$$T\hat{AMRP} = .1000 - .0247(1 - .30) = .083$$

In respect of surveys, the relevant survey is Fernandez et al (2015), which is closer in time to the relevant date (1 December 2014) than any other annual survey from the lead author. As discussed in section 7.5, the median of the estimates of the MRP for New Zealand from this survey is .060. Adjusted in accordance with equation (7) and the estimate for the one-year risk-free rate on 1 December 2014 of .0362, the resulting estimate of the TAMRP is .070 as follows:

$$T\hat{AMRP} = .060 + .0362(0.28) = .070 \qquad (28)$$

In respect of other markets, following section 7.5, the cross-country median estimate of the MRP for the relevant group of countries is .055. Adjusted in accordance with equation (7) and the one-year risk-free rate on 1 December 2014 of .0362, to provide an estimate of the TAMRP, the result is .065 as follows:

$$T\hat{AMRP} = .055 + .0362(0.28) = .065 \qquad (29)$$

The estimates discussed above are summarised in Table 5 below. As discussed in section 7.6, I favour use of the median result. Using only New Zealand data, the median estimate is .070. Using foreign data, the median estimate is .068. Collectively this suggests that an appropriate estimate of the one-year TAMRP on 1 December 2014 is .070.

Table 5: Estimates of the One-Year TAMRP on 1 December 2014

	New Zealand	Other Markets
Ibbotson estimate	7.2%	7.9%
Siegel estimate: version 1	6.0%	6.8%
Siegel estimate: version 2	7.4%	6.8%
DGM estimate	6.3%	8.3%
Surveys	7.0%	6.5%

Turning now to the four-year TAMRP on 1 September 2015, the process is identical in principle. In respect of the Ibbotson estimate using New Zealand data, this is 7.0% relative to the ten-year risk-free rate using data from 1931-2014 inclusive, as derived in section 7.2.[19] Obtaining an estimate relative to the four-year risk-free rate suffers from the difficulty that data to estimate this is only available in New Zealand since March 1985. However, data is available for estimation of the four and ten-year rates in the US since 1953. This allows an approximation as follows. Firstly, the average two and five-year rates in New Zealand from 1985-2014 inclusive have been 8.07% and 7.90% respectively, which implies an average four-year rate of 7.96%. In addition the average ten-year rate over the same period has been 7.97%, which implies a differential relative to the estimated four-year rate of 0.01%.[20] In addition, the average three, five, and ten-year risk-free rates in the US over the period April 1953 – February 1985 have been 6.31%, 6.42%, and 6.50% respectively, implying an average four-year rate of 6.36% and therefore a differential relative to the ten-year rate of 0.14%.[21] I extrapolate the latter differential to New Zealand for the same period and also to the earlier period 1931-1953. The average differential over the entire period 1931-2014 is then 0.08%. In addition, as discussed in section 7.2, the average tax rate on interest over the period since 1931 has been 0.29. So, the Ibbotson type estimate for the TAMRP over the 1931-2014 period using four-year risk free rates is the estimate of .070 based on ten-year rates, corrected for the rate differential (after tax) to yield .071 as follows:

$$TA\hat{M}RP = .070 + .0008(1 - .29) = .071 \tag{30}$$

In respect of other markets, and following section 7.2, I start with the cross-country average of the MRP estimates of the other 20 markets examined by Dimson et al (2015), which is .059 as shown in Table 3 above. To convert to a four-year estimate, I use the average differential between four and ten year US rates over the period 1953-2014 to proxy for the average differential in these markets over the longer period 1900-2014. The average US three, five, and ten-year rates over this period are 5.50%, 5.75%, and 6.05%, implying an average four-year rate of 5.62% and therefore a differential relative to the ten-year rate of 0.43% (data as per footnote 21). So, the average MRP estimate for these foreign markets

[19] This estimate uses data up till the end of 2014, which is eight months before the point in time at which the estimate is desired. This difference is considered inconsequential and is consistent with usage of the Dimson et al data, which is only available on a calendar year basis.

[20] Data from Table B2 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz).

[21] The rates are the three, five, and ten-year Treasury constant maturity rates (GS3, GS5, and GS10) reported at http://research.stlouisfed.org/fred2/categories/115.

based upon the four-year risk free rate is .0633. Following equation (7), and using the Commerce Commission's estimate of the New Zealand four-year risk free rate at 1 September 2015 of .0268, the resulting estimate of the TAMRP is .071 as follows:

$$T\hat{AMRP} = .0633 + .0268(0.28) = .071 \tag{31}$$

In respect of the Siegel version 1 estimate, as discussed in section 7.3, the estimate of .058 reflects the use of the ten-year risk-free rate, and requires the same adjustment to yield an estimate relative to the one-year risk-free rate as shown in equation (30). The result is .060 as follows:

$$T\hat{AMRP} = .058 + .0008(1 - .29) = .059 \tag{32}$$

In respect of other markets, as discussed in section 7.3, I start with cross-country average of the Siegel estimates of the MRP defined relative to the ten-year risk-free rate of .048. To obtain an estimate relative to the four-year risk-free rate, it is necessary to add the average differential between the four and ten year risk-free rates. Using US data over the 1953-2014 period, this differential is 0.43% as discussed above. Thus, with this adjustment, the Siegel estimate of the MRP is .0523. Converting this figure of .0523 to an estimate of the TAMRP, using equation (7) and the 1 September 2015 New Zealand one-year government stock rate of .0268, the result is an estimate of the TAMRP of .060 as follows:

$$T\hat{AMRP} = .0523 + .0268(0.28) = .060 \tag{33}$$

In respect of the Siegel version 2 estimate, and following section 7.3, I start with the estimate for the current nominal expected market return for New Zealand of .0996. Substitution into equation (7), along with the estimate for the 1 September 2015 New Zealand four-year government stock rate of .0268, yields a Siegel (version 2) estimate for the TAMRP of .080 as follows:

$$T\hat{AMRP} = .0996 - .0268(1 - .28) = .080 \tag{34}$$

In respect of other markets, and again following section 7.3, I start with the estimate for the current nominal expected market return of .0945. Converted to an estimate of the TAMRP in the same way as that underlying equation (34), the result is .075 as follows:

$$T\hat{AMRP} = .0945 - .0268(1 - .28) = .075 \qquad (35)$$

In respect of the DGM, as shown in section 7.4, the estimate for the expected rate of return on the New Zealand market portfolio on 1 September 2015 is .0933. Following equation (7), and the estimate for the four-year risk-free rate on 1 September 2015 of .0268, the resulting estimate of the TAMRP is .074 as follows:

$$T\hat{AMRP} = .0933 - .0268(1 - 0.28) = .074$$

In respect of other markets, following section 7.4, the same analysis is performed for Australia and the resulting estimate of the expected rate of return on the Australian market portfolio on 1 September 2015 is .1042. Deduction of the prevailing Australian four-year risk free rate of .0199 (interpolated from the August 2015 averages for three and five-year bonds of .0188 and .021) net of the tax adjustment (at the Australian corporate tax rate of 30%) in accordance with equation (7) then yields an estimate of the TAMRP of .090 as follows:

$$T\hat{AMRP} = .1042 - .0199(1 - .30) = .090$$

In respect of surveys, the relevant survey is Fernandez et al (2015). As discussed in section 7.5, the median of the estimates of the MRP for New Zealand from this survey is .060. Adjusted in accordance with equation (7) and the estimate for the four-year risk-free rate on 1 September 2015 of .0268, the resulting estimate of the TAMRP is .068 as follows:

$$T\hat{AMRP} = .060 + .0268(0.28) = .068$$

In respect of other markets, following section 7.5, the cross-country median estimate for the MRP for the relevant group of countries is .055. Adjusted in accordance with equation (7) and the four-year risk-free rate on 1 September 2015 of .0268, to provide an estimate of the TAMRP, the result is .063 as follows:

$$T\hat{AMRP} = .055 + .0268(0.28) = .063$$

The estimates discussed above are summarised in Table 6 below. As discussed in section 7.6, I favour use of the median result. Using only New Zealand data, the median estimate is .071. Using foreign data, the median estimate is also .071. Collectively this suggests that an appropriate estimate of the four-year TAMRP on 1 September 2015 is .070.

Table 6: Estimates of the Four-Year TAMRP on 1 September 2015

	New Zealand	Other Markets
Ibbotson estimate	7.1%	7.1%
Siegel estimate: version 1	5.9%	6.0%
Siegel estimate: version 2	8.0%	7.5%
DGM estimate	7.4%	9.0%
Surveys	6.8%	6.3%

In summary, the estimate for the one-year TAMRP on 1 December 2014 is 7.0% and likewise for the four-year TAMRP on 1 September 2015.

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