ESTIMATION OF THE TAMRP

26 September 2019

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CONTENTS

EXECUTIVE SUMMARY

This paper has updated an earlier (2015) estimate of the TAMRP, for application to three, four and five year periods. The same set of approaches that were used earlier have been used here, and warrant an estimate of .075 for all three terms rounded to the nearest 0.5%. By comparison with the 2015 estimates, the median estimates correspond to the Ibbotson estimates (or are very close to them) in all cases, and the Ibbotson estimates have risen by 0.3% since, thereby raising the overall estimate from .070 to .075.

1. Introduction

This paper seeks to update the estimate for the TAMRP provided in Lally (2015), using the same set of approaches but for application to three, four and five year periods.

2. Background

For estimating the cost of equity capital, the Commerce 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:

$$TAMRP = E(R_m) - R_f(1 - T_c) \tag{1}$$

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.

3. 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 2003-2018. For each year t, the ex-post counterpart to the TAMRP in equation (1) is

$$\hat{TAMRP}_t = R_{mt} - R_{ft}(1 - T_c) \tag{2}$$

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.[1] In respect of R_{mt}, Lally and

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

Marsden (2004a, Appendix A) deduced this from the NZX50 Gross Index return GR_{mt} (which includes the imputation credits) because there was no gross index at that time that excluded the credits. However, in 2005, a gross index was introduced without the imputation credits (NZX50G), with backdating to 2000, and the rate of change in this index is R_{mt}. The values for these parameters and the resulting values for $TA\hat{M}RP$ are shown in Table 1 below.[2]

Table 1: Ibbotson Estimates of the TAMRP for NZ 2003-2018

Year	R_m	T_c	R_f	$TA\hat{M}RP$
2003	.235	.33	.059	.196
2004	.227	.33	.061	.187
2005	.082	.33	.059	.042
2006	.203	.33	.058	.164
2007	-.003	.33	.063	-.045
2008	-.328	.30	.061	-.370
2009	.189	.30	.055	.151
2010	.024	.30	.056	-.015
2011	-.010	.28	.050	-.046
2012	.242	.28	.037	.215
2013	.165	.28	.041	.135
2014	.175	.28	.043	.144
2015	.136	.28	.034	.111
2016	.088	.28	.028	.068
2017	.220	.28	.030	.199
2018	.049	.28	.027	.029
Average				.073

[2] The TAMRP figures shown in Table 1 above for 2003-2014 are slightly higher than those in Lally (2015, Table 1) because the former used a less satisfactory approach in the mistaken belief that there was no Gross Index at that time that excluded the credits and that the Gross Index used included the credits. The effect of the correction was to raise the 2003-2014 estimate for the TAMRP from .053 to .063 and therefore to raise the 1931-2014 estimate (relative to the ten-year risk-free rate) from .070 to .0714. Addition of extra four years of data (2015-2018), with a higher estimate for the TAMRP of .102 for these years, raises the TAMRP estimate for 1931-2018 to .073. Ex-post correction of the error in Lally (2015) would not have changed the TAMRP estimate of .070 for one, four and five years, rounded to the nearest 0.5%.

As shown in the table, the average of these ex-post values for the TAMRP is .073. This average over 16 years is combined with the estimate of .073 for 1931-2002 (72 years), to yield the updated estimate of the TAMRP of .073 as follows:

$$\widehat{TAMRP} = .073\left(\frac{72}{88}\right) + .073\left(\frac{16}{88}\right) = .073$$

This estimate of the TAMRP is defined relative to the ten-year risk-free rate, and is therefore applicable to a ten-year period. By contrast, the estimates sought here are for three, four and five year periods, and therefore requires use of the three, four and five year risk-free rates. In respect of the three-year risk-free rate, data is only available in New Zealand from March 1985. Nevertheless, data is available on both three and ten-year rates in the US from April 1953. This allows an estimate as follows. Firstly, the average differential for the New Zealand three and ten year rates from 1985-2018 inclusive has been 0.13%.[3] In addition, the average differential for the US three and ten year rates over the period 1953-1985 has been 0.19%.[4] I extrapolate the latter differential to New Zealand for the same period and also to the earlier period 1931-1953. The time-weighted average differential over the entire period 1931-2018 is then 0.17%. In addition the average tax rate on interest over the period since 1931 has been 0.29.[5] So, the Ibbotson type estimate for the TAMRP over the 1931-2018 period using three-year risk free rates is the estimate of .073 based on ten-year rates, corrected for the rate differential (after tax) to yield .074 as follows:

$$\widehat{TAMRP} = .073 + .0017(1 - .29) = .074 \qquad (3)$$

In respect of the five-year rate, the average differential for ten over five year risk-free rates in New Zealand over the 1985-2018 period was 0.12% whilst the average differential for the US

[3] Data from Table B2 on the website of the Reserve Bank of New Zealand (www.rbnz.govt.nz). The ten-year rates are reported but not the three-year rates, so the latter are interpolated from the two and five year series or the one and five-year series from Nov 2013 to Nov 2014 when the two-year series was unavailable. This yielded a three-year average of 7.25% and a ten-year average of 7.38%.

[4] The rates are reported at http://research.stlouisfed.org/fred2/categories/115, and average 6.31% for the three-year constant-maturity bonds (GS3) and 6.50% for the ten-year constant-maturity bonds (GS10).

[5] This comprises an average of 0.28 over the pre-imputation period 1931-1987 and an average of 0.31 from 1988-2018 (with the figures 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 2.1)).

over the 1953-1985 period was 0.08%. Extrapolating the latter differential to New Zealand for the same period and also to the earlier period 1931-1953, the time-weighted average differential over the entire period 1931-2018 is then 0.10%. Substituted into equation (3) instead of the figure of 0.17%, the resulting estimate of the TAMRP is also .074. In respect of the four-year rate, the corresponding figures are 0.13%, 0.14% and 0.14%, leading again to a TAMRP estimate of .074.

In respect of other markets, tax regimes typically differ across markets, and differences would be reflected in the definition of the TAMRP. However, when defined to reflect the tax regime in each market, the values for TAMRP would differ across markets only in so far as risk or risk aversion differed. Accordingly, the conceptually best approach would be to replicate the analysis in Lally and Marsden (2004a) for each foreign market, taking account of the tax regime in each market and at each point at which data was used, and then average over the results. This would involve starting with the general version of equation (1), as shown in Lally (1992, page 32), which allows for differing personal tax rates on interest (T), dividends (T_d), and capital gains (T_g). Letting D_m denote the market dividend yield, this general form is as follows:

$$TAMRP = E(R_m) - D_m\left(\frac{T_d - T_g}{1 - T_g}\right) - R_f\left[1 - \left(\frac{T - T_g}{1 - T_g}\right)\right] \qquad (4)$$

For each foreign market, it would be necessary to determine the tax regime operating in each year for which historical data is collected, then the appropriate form for equation (4) for each such year, then the ex-post counterpart for each such year, followed by collection of the relevant data and then averaging over time for each market. This requires data that is not readily available. However, it is possible to estimate the result for a typical foreign tax regime, over both markets and time. Doing so involves recognising three typical features of the taxation of dividends and capital gains relative to interest. Firstly, in general, capital gains are levied on realisation rather than as they arise, and the resulting opportunity to defer payment of the tax reduces the effective tax rate by approximately 50% (Protopapadakis, 1983)[6]. Secondly, capital gains are or have been less heavily taxed than interest in many cases. For example, they are currently taxed at significantly lower rates in Australia, are currently exempt in Switzerland,

[6] The deferral lowers the effective tax rate not only because of the time value of money but also, as Hamson and Ziegler (1990, p. 49) note, because gains can be realised when the investor's tax rate is lower, such as in retirement.

and were exempt in Austria before 2010 and in Australia before 1985.[7] Thirdly, dividends are or have been less heavily taxed than interest in many cases. For example, they have been largely tax-free in Australia since the introduction of imputation in 1987, they were largely tax free due to the use of imputation in the UK in the 1973-1999 period, they were exempt until 1954 in the US, and have been taxed in the US at only 15% since 2003.[8] This suggests that the average effective capital gains tax rate since 1900 has been about 25% of that on interest (a 50% reduction due to deferral and a further 50% due to lower rates) whilst that on dividends has been about 50% of that on interest. Coupling these assumptions with equation (4) gives the TAMRP in each year of approximately

$$TAMRP = E(R_m) - D_m 0.25T - R_f(1 - 0.75T) \tag{5}$$

The TAMRP estimate for year *t* would then be as follows:

$$\widehat{TAMRP}_t = (R_{mt} - R_{ft}) + R_{ft}(0.75T_t) - D_{mt}(0.25T_t) \tag{6}$$

Averaging over time and then markets then produces the required estimate. In respect of ($R_{mt} - R_{ft}$), Dimson et al (2019) presents estimates of the standard market risk premium in 22 foreign markets (using the ten-year risk-free rate), using data from 1900-2018.[9] With the exceptions of China, Russia, and South Africa, they can all be regarded as 'developed' economies and therefore suitable comparators for New Zealand. The mean of these 19 point estimates is .060 (see Table 3 below). To convert to an estimate relative to the three-year risk-free rate, I use the average differential between three and ten year US rates over the period 1953-2018 to proxy for the average differential in these markets over the longer period 1900-2018. The average US differential is 0.56% (data as per footnote 3), and therefore the median MRP estimate for these foreign markets based upon the three-year risk-free rate is .0656. In respect of the remaining terms in equation (6), historical data on the parameters D_{mt} and T_t for every one of

[7] See https://en.wikipedia.org/wiki/Capital_gains_tax and http://taxsummaries.pwc.com/ID/Austria-Individual-Income-determination.

[8] See https://en.wikipedia.org/wiki/Dividend_imputation and https://www.dividend.com/taxes/a-brief-history-of-dividend-tax-rates/.

[9] 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.

these foreign markets is not readily available. So, I invoke New Zealand data. Over the period 1931-2002, the average (ten-year) R_{ft} for New Zealand was .067 (Lally and Marsden, 2004a, Table 2), and the average for 2003-2018 was .048[10], yielding a 1931-2018 time-weighted average of .064. This involves ten-year risk-free rates and the average differential for ten versus three year rates over the same period is estimated at 0.17% (see above), yielding an average three-year risk-free rate over the 1931-2018 period of .062. In addition, the average D_m for New Zealand for 1931-2002 was .050 (Lally and Marsden, 2004a), whilst that for 2003-2018 was .051 (data from Bloomberg), yielding an average for 1931-2018 of .050. In respect of T, the average tax rate on interest in New Zealand over the period since 1931 has been 0.29 (see footnote 4). Substitution of these estimates into equation (6) yields an estimate for the TAMRP of a typical foreign market of .076 as follows:

$$T\widehat{AMR}P = .0656 + .062(.22) - .050(.07) = .076 \tag{7}$$

In respect of the four-year risk-free rate, the average differential between four and ten year US rates over the period 1953-2018 is used to estimate the average differential in these foreign markets over the longer period 1900-2018, the differential is 0.44% (data as per footnote 3), and therefore the mean MRP estimate for these foreign markets based upon the four-year risk-free rate is .0644. In addition, over the period 1931-2018, the average (ten-year) risk-free rate for New Zealand was .064 (as noted above), the average differential for ten versus four-year rates over the same period is estimated at 0.14% (see above), yielding an average four-year risk-free rate over the 1931-2018 period of .063. Substitution of these figures of .0644 and .063 into equation (7) in substitution for the figures of .0656 and .062 respectively yields an estimate of the TAMRP of .075. In respect of the five-year risk-free rate, the corresponding figures are 0.31% for the differential between five and ten year US rates over 1953-2018, .0631 for the mean MRP for foreign markets based on the five-year risk-free rate, .064 for the average New Zealand ten-year risk-free rate for 1931-2018, 0.10% for the average differential for ten versus five-year rates over the same period, and .063 for the average New Zealand five-year risk-free rate over the same period, yielding an estimate for the TAMRP of .073.

4. Siegel Estimates

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

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 (involving historical averaging of R_m - R_f) is unusually high using data from 1926-1990, due to the very low real returns on government 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 TAMRP 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 from their inception in 1996 to 2002, of .036.[11] 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 2003-2018. For each year, the estimate of the Siegel-type estimate of the TAMRP is as follows:

$$TA\hat{M}RP(S)_t = TA\hat{M}RP_t + R_{ft}^r(1-T_c) - 0.035(1-T_c) \qquad (8)$$

The values for $TA\hat{M}RP$ for 2003-2018 are shown in Table 1 along with the ten-year nominal risk-free rates for those years, and are reproduced in Table 2 below. Table 2 also shows CPI inflation rates for these years[12], and this is used to convert the ten-year nominal risk-free rates for these years to real rates. Substitution into equation (8) then yields the Siegel-type estimate of the TAMRP for each year, as shown in Table 2 below. As shown in the table, the average of these Siegel-type estimates for the TAMRP is .067. This average over 16 years is combined

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

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

with the estimate of .059 for 1931-2002 (72 years), to yield the updated Siegel-type estimate of the TAMRP of .060 as follows:

$$\widehat{TAMRP} = .059\left(\frac{72}{88}\right) + .067\left(\frac{16}{88}\right) = .060 \quad (9)$$

This Siegel-type estimate of the TAMRP uses ten-year risk-free rates at two points in the calculation, firstly in equation (2) and then in (8), and these offset. So, no adjustment is required to convert to the use of three-year risk-free rates. The same applies to four and five year risk-free rates.

Table 2: Siegel-Type Estimates of the TAMRP for NZ 2003-2018

Year	R_f	Inf	R_f^r	$T\hat{AMRP}$	$T\hat{AMRP}(S)$
2003	.059	.016	.042	.196	.200
2004	.061	.027	.033	.187	.185
2005	.059	.032	.026	.042	.036
2006	.058	.026	.031	.165	.162
2007	.063	.032	.030	-.045	-.049
2008	.061	.034	.026	-.370	-.377
2009	.055	.020	.034	.151	.150
2010	.056	.040	.015	-.015	-.028
2011	.050	.018	.031	-.046	-.049
2012	.037	.009	.028	.216	.210
2013	.041	.016	.025	.135	.128
2014	.043	.008	.035	.144	.144
2015	.034	.001	.033	.111	.110
2016	.028	.013	.014	.068	.053
2017	.030	.016	.014	.199	.184
2018	.027	.019	.008	.029	.010
Average					.067

In respect of other markets, as with the Ibbotson approach, the conceptually appropriate approach would be to replicate the analysis in Lally and Marsden (2004b) for each foreign market, and then average over the results. This would involve starting with the Ibbotson estimate for each market, and then replacing the historical average real risk-free rate within that estimate by .035. Since Ibbotson-type estimates are not available for all foreign markets, and a typical case is instead considered in equations (6) and (7), that Ibbotson estimate of .076 is modified. The result then is as follows:

$$\widehat{TAMRP} = .076 + (\overline{R_f^r} - .035)(1 - .75\bar{T}) \qquad (10)$$

Across the 19 markets for which data is used to generate the Ibbotson estimate in equation (7), the average real risk-free rate is .022 as shown in Table 3. In addition, the average historical value for T using New Zealand data is 0.29, as noted above. Substitution into equation (10) yields a Siegel-type estimate for the TAMRP of .066 as follows:

$$\widehat{TAMRP} = .076 + (.022 - .035)(1 - .22) = .066$$

As with the Siegel-type estimate using only New Zealand data as shown in equation (8), no adjustment in required to the use of ten-year risk-free rates because their use at two different points in the calculation offsets.

Table 3: Historical Average Returns for Foreign Markets

Country	$\widehat{MRP}$	$\bar{R}_f^r$	$\bar{R}_m^r$
Australia	.060	.025	.082
Austria	.101	.047	.050
Belgium	.041	.016	.051
Canada	.045	.027	.070
Denmark	.049	.028	.072
Finland	.088	.015	.092
France	.054	.012	.057
Germany	.079	.013	.080
Ireland	.043	.026	.067

Italy	.068	.002	.058
Japan	.077	.017	.086
Netherlands	.052	.022	.070
Norway	.051	.025	.072
Portugal	.095	.001	.083
Spain	.033	.026	.057
Sweden	.048	.034	.079
Switzerland	.037	.027	.062
UK	.049	.027	.072
US	.061	.024	.083
Average	.060	.022	.071

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, to estimate the TAMRP for New Zealand, one could estimate the expected real market return from the historical average, convert to its current nominal counterpart using a current inflation forecast, and then deduct the current three-year risk-free rate (net of tax) in accordance with equation (1). Using data from 1900-2018, the average real market return for New Zealand was .079 (Dimson et al, 2019, Table 50). 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 .1006. Substitution into equation (1) along with the current New Zealand three-year government stock rate of .0084 (August 2019 average)[13], yields a Siegel (version 2) estimate for the TAMRP of .095 as follows:

$$\widehat{TAMRP} = .1006 - .0084(1 - 0.28) = .095 \qquad (11)$$

In respect of the current New Zealand four and five year risk-free rates, these are .0086 and .0088 respectively (August 2019 averages). Substitution into equation (11) in substitution for the figure of .0084 yields a four-year estimate of the TAMRP of .094 and a five-year estimate of .094.

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

In respect of other markets, and consistent with the Ibbotson approach, a typical case is considered, corresponding to equation (5). Across the 19 foreign markets considered above, the average real market return was .071 as shown in Table 3. Converted to a current nominal expected market return using expected inflation yields the estimate for $E(R_m)$, whilst the remaining terms in (5) are estimated using current data. To simplify the process, current New Zealand data is used for these additional steps. Using expected inflation of .020 (the midpoint of the Reserve Bank's target range), the resulting estimate of $E(R_m)$ is .0924. In addition the current New Zealand three-year government stock rate is .0084 (August 2019 average), the current dividend yield is .0337 (24 September 2019 data from Bloomberg), and the current value for T is .28. Substituted into equation (5), the resulting estimate of the TAMRP for a typical foreign market is .083 as follows:

$$\widehat{TAMRP} = .0924 - .0337(.07) - .0084(1 - 0.21) = .083$$

In respect of the current New Zealand four and five year risk-free rates, these are .0086 and .0088 respectively (April 2019 averages). Substitution into the last equation in substitution for the figure of .0084 yields a four-year estimate of the TAMRP of .083 and a five-year estimate of .083.

A peculiarity of the last two sets of TAMRP estimates (for New Zealand and a typical foreign market) is that they all use expected inflation of 2.0% in conjunction with a risk-free rate of 1.51% - 1.58%, which implies a negative expected real risk-free rate. This is not because credible forecasters are expecting a materially lower inflation rate over the next three to five years; The Treasury (2018) forecasts inflation at 2.0% for each of the years 2019-2023 whilst Westpac (2019) forecasts 2.0% on average over these years and ANZ (2019) forecasts 1.8% on average over the next three years. Furthermore, even if the inflation forecasts reflected in the prevailing three to five year risk-free rate were lower by as much as 0.5%, and therefore both sets of estimates of the TAMRP were lower by the same amount, this would not affect the overall estimate of the TAMRP.

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 estimated at .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 should be considered.

5. The Dividend Growth Model

A Dividend Growth Model (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) involves 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:

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

$$= \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + ... + \frac{D_{11}}{(1+k)^{11}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{11}} \qquad (12)$$

Solving (numerically) for k, and then deducting the prevailing risk free rate (net of tax) in accordance with equation (1), yields the estimate of the TAMRP for New Zealand.

Equation (12) 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 term of discounting is reduced by six months in respect of each year and equation (12) becomes:

$$S_0 = \frac{D_1}{(1+k)^{0.5}} + \frac{D_2}{(1+k)^{1.5}} + \frac{D_3}{(1+k)^{2.5}} + ... + \frac{D_{11}}{(1+k)^{10.5}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{10.5}} \qquad (13)$$

Finally, estimates of expected dividends are generally performed for calendar years and therefore equation (13) assumes that the current point in time is the beginning of a calendar year. If the analysis is done part way through the calendar year, with proportion *y* of the year remaining, then following Pratt and Grabowski (2010, equation (4.18)), equation (13) becomes:[14]

$$S_0 = \frac{D_1 y}{(1+k)^{y/2}} + \frac{D_2}{(1+k)^{0.5+y}} + \frac{D_3}{(1+k)^{1.5+y}} + ... + \frac{D_{11}}{(1+k)^{9.5+y}} + \frac{\left[\frac{D_{11}(1+g)}{k-g}\right]}{(1+k)^{9.5+y}} \qquad (14)$$

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. Following Cornell (1999, Ch. 4), an appropriate estimate for the long-run expected growth rate in DPS would equal the expected long-run real growth in GDP (g_e) less a deduction (d) for the net creation of new shares from new companies and new share issues (net of buybacks) from existing companies, converted to a nominal rate using expected inflation of *i*, i.e.,

$$g = [1 + (g_e - d)](1 + i) - 1 \qquad (15)$$

In respect of g_e, New Zealand's real GDP growth rate over the period 1900-2013 averaged 3%, with 3% also from 1945 (CEG, 2014, page 73). For 2013-2018, the average has been 3.4%.[15] So, the 1900-2018 average has been 3%. In addition, 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

[14] Pratt and Grabowski (2010, equation (4.18)) mistakenly contains the term *n* instead of *n*-1. The test is thus: if *y* = 1, Pratt and Grabowski's equation (4.18) must collapse to their equation (4.14), which does not occur unless *n*-1 substitutes for *n*.

[15] Data from Table M5 on the Reserve Bank's website (www.rbnz.govt.nz).

devastation during wars. This suggests g_e = .03 for New Zealand, and CEG (ibid, in a report for Chorus) concur with this. In respect of *d*, Lally (2013, sections 7 and 8) examines this issue and concludes that an appropriate deduction would be 0.5 - 1.5% for these developed markets. This suggests using *d* = .01, and CEG (ibid) concurs with this. In respect of *i*, an appropriate estimate is the midpoint of the Reserve Bank's target range, of 2%. CEG (2014, page 73) also concurs with this. Substitution of these parameter values into equation (15) yields *g* = .04. The same estimate was used by Lally (2015, section 7.4).

As at 24 September 2019, Bloomberg's expected dividends for the NZX50 index for the calendar years 2019 and 2020 expressed as a proportion of the index value on 24 September 2019 were .0337 and .0357 respectively (implying *y* = 0.27 and an expected growth rate in the second year of .059).[16] Substitution of these parameter values into equation (14), along with *g* = .04, yields *k* = .0791. Deduction of the prevailing three-year risk free rate of .0084 (August 2019 average[17]) net of the tax adjustment in accordance with equation (1) then yields an estimate of the TAMRP of .073 as follows

$$\widehat{TAMRP} = .0791 - .0084(1 - .28) = .073 \qquad (16)$$

In respect of the current New Zealand four and five year risk-free rates, these are .0086 and .0088 respectively (August 2019 averages). Substitution into equation (16) in substitution for the figure of .0084 yields a four-year estimate of the TAMRP of .073 and a five-year estimate of .073.

In respect of other markets, the same approach is applied to Australia. As at 24 September 2019, Bloomberg's expected dividends for the ASX200 index for the calendar years 2019, 2020 and 2021 expressed as a proportion of the index value on 24 September 2019 were .0418, .0420 and .0427 respectively (implying *y* = 0.27 and an expected growth rate from

[16] Bloomberg also offers a forecast for the market dividend yield for year 3, but the time series of these forecasts reveals a jump from 3.62% on 22 July 2019 to 4.63% on 23 July 2019, due to a jump in the dividend yield forecast for Goodman Property Trust from 3.3% to 57.4%. Attempts to obtain an explanation from Bloomberg for this extraordinary jump were not successful. If it is an error, the market dividend forecast for year 3 warrants ignoring. If it is not an error, then it is so large that it could not be maintained in future years, let alone warrant projecting the rate of increase from year 1 to 3 to subsequent years. Either way, the market dividend yield forecast for year 3 should not be used.

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

the first to the third year of .011 per year). In respect of equation (15), an appropriate estimate for expected inflation is 2.5% (the midpoint of the Reserve Bank of Australia's target range). In addition, Australia's real GDP growth rate has averaged 3.2% for 1900-2018[18], whilst average real GDP growth rates over 16 developed countries over the period 1900-2000 averaged 2.8% rising to 3.0% with exclusion of those countries that suffered devastation during wars (Bernstein and Arnott (2003, Table 1)). This suggests g_e = .03 for Australia. In addition, d is estimated at .01 as discussed above. Substitution into equation (15) yields g = .046 as follows:

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

Substitution of these parameter values into equation (14) yields k = .0840. Unlike New Zealand, this estimate cannot be substituted into equation (1) because this equation does not reflect the current Australian tax regime, due to the taxation of capital gains. Taxation of gains upon realisation reduces the effective rate by about 50%, and the use of lower statutory rates than on interest reduces it by a further 50%, to yield an effective tax rate on capital gains of about 25% of that on interest. Following equation (4), the TAMRP for Australia should then be as follows:

$$TAMRP = E(R_m) + D_m(.25T) - R_f(1 - .75T) \qquad (17)$$

In addition, the prevailing Australian three-year risk-free rate is .0069 (August 2019 average[19]), the prevailing dividend yield is .0418 (as above), and T is estimated at the current Australian corporate tax rate of .30. Substitution of these parameter values into equation (17) then yields an estimate of the TAMRP for Australia of .082 as follows:

$$\widehat{TAMRP} = .0840 + .0418(.075) - .0069(1 - .225) = .082 \qquad (18)$$

In respect of the current Australian four and five year risk-free rates, these are .0070 and .0071 respectively (August 2019 averages). Substitution into equation (18) in substitution for the

[18] This comprises 3.3% for 1900-2011 (see Lally, 2013, page 17) and 2.5% for 2012-2018 (RBA website Table HI: www.rba.gov.au/statistics/tables).

[19] Data from Table F2 on the website of the Reserve Bank of Australia (www.rba.gov.au).

figure of .0069 yields a four-year estimate of the TAMRP of .082 and a five-year estimate of .082.

This DGM 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 for NZ and a lower one for Australia. 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. So the point estimates in equations (16) and (18) are merely indicative.

6. Surveys

The most important characteristics of survey results are that they are recent, that the responses are the product of very careful consideration, that they are regularly updated, and that they contain results for other markets. No available survey satisfies all four requirements but the Fernandez et al (2019) survey (which is conducted annually) clearly satisfies all but the second requirement. The survey provides estimates of the standard MRP in 69 markets including New Zealand (ibid, Table 2). This table provides both means and medians, and therefore a choice must be made. The MRP is a mathematical expectation corresponding to the mean of a distribution of returns, and therefore the mean of any sample of returns must be used to estimate it rather than the median. However, the survey respondents' estimates of the MRP are subjective estimates of it rather than returns data, and therefore there is no requirement to use the mean response. Furthermore, one could reasonably suspect that some of the responses to this survey are frivolous or 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% (Fernandez, 2015, 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 switched in 2014 to use of the median response (Lally, 2014, section 3) and adopt the same policy here. The median of the estimates of the MRP for New Zealand is .059 (from 32 responses), and the survey was conducted in February 2019. Adjusted in accordance with equation (1) and the contemporaneous three-year risk-free rate of 0.0169 (February 2019 average), the resulting estimate of the TAMRP is .064 as follows:

$$\widehat{TAMRP} = .059 + .0169(0.28) = .064$$

In respect of the contemporaneous New Zealand four and five year risk-free rates, these are both .0170 (February 2019 averages). Substitution into the last equation in substitution for the figure of .0169 yields a four and five year estimate of the TAMRP of .064.

Turning to the remaining 68 markets, there are clearly two distinct groups, comprising 24 'developed' countries or equivalents (high income but not oil dominated, comprising those in Western Europe, US, Canada, Japan, South Korea, Singapore, Taiwan, and Hong Kong), and 44 others (which are middle income or oil dominated). For each of these two subsets, the cross-country means of the within country medians is .063 for the 24 'developed' countries and .081 for the others, and there is minimal overlap in the two subsets.[20] New Zealand is clearly comparable with the first group, and I therefore invoke the cross-country mean for that group, of .063. As with the Ibbotson and Siegel estimates for foreign markets, equation (5) is invoked to reflect the tax regime in a typical foreign market, i.e.,

$$TAMRP = E(R_m) - R_f - D_m(0.25T) + R_f(.75T) \tag{19}$$

The average survey result of .063 provides an estimate of $E(R_m) - R_f$. In respect of the other parameters, the parameter values should also be current. In view of the difficulties in collecting data on 24 markets, New Zealand values are used; these are .0169 for the three-year R_f, (see above), .0337 for D_m (see previous section), and 0.28 for T (the current corporate tax rate). Substitution into equation (19) yields an estimate of the TAMRP for a typical foreign market of .066 as follows:

$$\widehat{TAMRP} = .063 - .0337(.07) + .0169(.21) = .066$$

[20] Using .065 as the dividing line, only 2/24 of the first group of countries have a median MRP estimate that exceeds that figure and only 3/44 of the second group have a median MRP estimate that is less than that figure.

As noted above, the contemporaneous New Zealand four and five year risk-free rates are almost identical to the three-year rate, and their use does not alter the TAMRP estimate here.

7. Overall Results

The estimates determined above are summarised in Table 4 below. I favour use of the median results because doing so reduces the impact on the estimate from an extreme outcome arising from one of the methods.

Table 4: Estimates of the TAMRP with Three Four and Five Year Risk-Free Rates

	New Zealand			Other Markets		
Ibbotson estimate	.074	.074	.074	.076	.075	.073
Siegel estimate: version 1	.060	.060	.060	.066	.066	.066
Siegel estimate: version 2	.095	.094	.094	.083	.083	.083
DGM estimate	.073	.073	.073	.082	.082	.082
Surveys	.064	.064	.064	.066	.066	.066
Median	.073	.073	.073	.076	.075	.073

Using only New Zealand data, the median estimate is .073 for all three terms. Using foreign data, the median estimate is .073 - .076 depending upon the term. Lally and Randal (2015) examine estimators of the MRP and show that the optimal estimator for a country should place high weight on foreign data because estimates using only local data are very noisy and the true MRPs do not vary greatly across countries. However, this conclusion presumes that the data underlying these MRP estimates is foreign, whereas the 'foreign' estimates in Table 4 have in many cases used some New Zealand data, thereby reducing the value of these 'foreign' estimates. All of this suggests that an appropriate estimate of the TAMRP at the present time is .075, for three, four and five year terms and when estimated to the nearest 0.5%. By comparison with the estimates in Lally (2015), the median estimates correspond to the Ibbotson estimates (or are very close to them) in all cases, and the Ibbotson estimates have risen by 0.3%, thereby raising the overall (rounded) estimate from .070 to .075. This rise in the Ibbotson estimates for New Zealand is due in approximately equal measure to correction of an error in the 2015 estimates and to the higher values in the additional four years of data (see footnote 2).

8. Conclusions

This paper has updated an earlier (2015) estimate of the TAMRP, for application to three, four and five year periods. The same set of approaches that were used earlier have been used here, and warrant an estimate of .075 for all three terms rounded to the nearest 0.5%. By comparison with the 2015 estimates, the median estimates correspond to the Ibbotson estimates (or are very close to them) in all cases, and the Ibbotson estimates have risen by 0.3% since, thereby raising the overall estimate from .070 to .075.

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