

29 April 2011

The Market Risk Premium

A report for Multinet Gas and SP
AusNet



NERA

Economic Consulting

Project Team

Simon Wheatley

Brendan Quach

NERA Economic Consulting
Darling Park Tower 3
201 Sussex Street
Sydney NSW 2000
Tel: +61 2 8864 6500
Fax: +61 2 8864 6549
www.nera.com

Contents

Executive Summary	2
1 Introduction	1
1.1 Statement of Credentials	1
2 Estimating the <i>MRP</i>	3
2.1 The Changing Properties of the Market Portfolio	3
2.2 Current Conditions	8
3 Survey Evidence	11
3.1 Merits of Survey Evidence	11
3.2 Importance of Franking Credits	13
3.3 Surveys and Imputation	13
4 Implied Volatility as a Predictor of the <i>MRP</i>	16
4.1. Theory	16
4.2. Link Between Implied Volatility and Realised Volatility	17
4.3. Implied Volatility and the <i>MRP</i>	19
4.4. Current Market Conditions	20
4.5. Other Models	21
5 Conclusions	22
Appendix A. Data	24
Appendix B. F-test	25
Appendix C. Expert Witness Guidelines	28

List of Tables

Table A.1 Volatility data

24

List of Figures

Figure 2.1 Stock market variance by half decade	5
Figure 2.2 Stock market volatility by half decade	6
Figure 2.3 BBB-AAA yield spread	9
Figure 3.1 Survey question posed by Fernández (2009)	14
Figure 3.2 Survey question posed by Fernández and del Campo (2010)	15
Figure 4.1 Volatility implied by a three-month call option on the ASX 200	20

Executive Summary

This report has been prepared for Multinet Gas and SP AusNet by NERA Economic Consulting (NERA). Multinet Gas and SP AusNet have asked NERA to examine a number of issues that arise from the recently published *Envestra Ltd Access arrangement proposal for the SA gas network, 1 July 2011 – 30 June 2016: Draft Decision* provided by the Australian Energy Regulator (AER).

In particular, Multinet Gas and SP AusNet have asked NERA to assess:

- whether the historical evidence indicates that a long-term average market risk premium (*MRP*) of 6 per cent per annum inclusive of the value of imputation credits is appropriate;
- whether current conditions warrant an *MRP* at its long-term average or above its long-term average;
- whether the survey papers of Fernández (2009) and Fernández and del Campo (2010) to which the AER refers provide support for an *MRP* of 6 per cent per annum inclusive of the value of imputation credits; and
- whether the volatility of the return to the market portfolio implied by option prices can provide a guide as to the *MRP*.

We document that:

- the historical evidence indicates that the Australian market portfolio was substantially less risky in the later part of the 19th century and the earlier part of the 20th century than in the later part of the 20th century and the start of the 21st century. The variance of the return to the Australian market portfolio has been *three times* as high in the later period than in the earlier period. This empirical result casts considerable doubt on the wisdom of the AER's decision to combine, without any adjustment for differences in risk, data from the earlier period with data from the later period in order to estimate the *MRP*. Either adjusting the earlier data or throwing out the earlier data will lead to an *MRP* of at least 6.5 per cent per annum;
- current conditions suggest that the *MRP* is above its long-term average. The spread between BBB bond yields and AAA bond yields, while lower than during the worst of the Global Financial Crisis, is still *well above* its long-run average. Also the volatility of the return to the Australian market portfolio implied by option prices suggests that the risk of the market sits at a level that is above where it sat for much of the last decade;
- the survey papers of Fernández (2009) and Fernández and del Campo (2010) provide little information about whether responders are measuring the Australian *MRP* inclusive or exclusive of imputation credits. The only piece of evidence pertaining to the issue in the papers indicates that responders are measuring the *MRP exclusive* of imputation credits. A weighted average of the Australian responses adjusted for the value of imputation credits indicates that inclusive of the value of imputation credits the *MRP* is at least 6.5 per cent per annum;
- there is evidence in the literature that the volatility of the return to the market portfolio implied by option prices *can* provide a guide as to the *MRP*. In addition, the implied volatility of stock market returns, inferred from option prices, is a reasonable predictor of

future volatility. The AER has misinterpreted the results of a study by Chernov (2007) which actually suggests that there is information about future volatility contained in implied volatility;¹ and

- the literature also documents, consistent with the existence of a positive link between expected volatility and the *MRP*, that there is a negative relation between unexpected changes in volatility and the return to the market portfolio.

¹ Chernov, M., *On the role of risk premia in volatility forecasting*, Journal of Business and Economic Statistics, 2007, page 411.

1 Introduction

This report has been prepared for Multinet Gas and SP AusNet by NERA Economic Consulting (NERA). Multinet Gas and SP AusNet have asked us to examine a number of issues that arise from the recently published *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision* provided by the Australian Energy Regulator (AER).

In particular, Multinet Gas and SP AusNet have asked us to assess:

- whether the historical evidence indicates that a long-term average market risk premium (*MRP*) of 6 per cent per annum inclusive of the value of imputation credits is appropriate;
- whether current conditions warrant an *MRP* at its long-term average or above its long-term average;
- whether the survey papers of Fernández (2009) and Fernández and del Campo (2010) to which the AER refers provide support for an *MRP* of 6 per cent per annum inclusive of the value of imputation credits; and
- whether the volatility of the return to the market portfolio implied by option prices can provide a guide as to the *MRP*.

The remainder of this report is structured as follows:

- Section 2 – examines estimates of the *MRP* provided by the AER and its advisors;
- Section 3 – examines the use by the AER of survey data to gauge the *MRP*;
- Section 4 – examines the use of volatility implied by options to predict the *MRP*.

Appendix A describes the data used in Section 2 to examine the behaviour of the Australian market portfolio through time.

1.1 Statement of Credentials

This report has been jointly prepared by **Simon Wheatley** and **Brendan Quach**.²

Simon Wheatley is a Special Consultant with NERA, and was until recently a Professor of Finance at the University of Melbourne. Since 2008, Simon has applied his finance expertise in investment management and consulting outside the university sector. Simon's expertise is in the areas of testing asset-pricing models, determining the extent to which returns are predictable and individual portfolio choice theory. Prior to joining the University of Melbourne, Simon taught finance at the Universities of British Columbia, Chicago, New South Wales, Rochester and Washington.

Brendan Quach is a Senior Consultant at NERA with ten years experience as an economist, specialising in network economics and competition policy in Australia, New Zealand and Asia Pacific. Since joining NERA in 2001, Brendan has advised a wide range of clients on

² If requested a complete curriculum vitae can be provided for each of the authors.

regulatory finance matters, including approaches to estimating the cost of capital for regulated infrastructure businesses.

We have read the Guidelines for Expert Witnesses in Proceedings of the Federal Court of Australia. A copy of these guidelines is attached at Annexure C to this report. We confirm that all inquiries that we believe are desirable have been made and no matters of significance which we regard as relevant have, to the best of our knowledge, been withheld.

2 Estimating the *MRP*

The AER recognises that the *MRP* changes through time. This is clear because in 2009 the AER raised the *MRP* from 6 to 6.5 per cent on account of the effects of the global financial crisis. In its 2011 Draft Decision,³ the AER has stated that it now plans to lower the *MRP* from 6.5 per cent to 6 per cent. What is not so clear is the process that the AER is using to determine when the *MRP* should be changed and by how much it should be changed when it is.

These concerns are also linked to the question of whether the AER should be using an estimate of the *MRP* based in part on a very long time series of returns when there is clear evidence that indicates that the properties of the Australian market portfolio have changed substantially over time.

We start by examining the properties of the Australian market portfolio over the last 128 years – the longest period that the AER and its advisors examine.

2.1 The Changing Properties of the Market Portfolio

In arriving at an estimate of the *MRP* of 6 per cent the AER uses the following estimates provided by Handley (2011):⁴

Table 5.4: Historical excess return estimates (assuming an imputation credit utilisation rate of 0.65)

	Historical excess returns	95% confidence interval
1883–2010	6.3%	3.4% – 9.2%
1937–2010	6.1%	1.5% – 10.7%
1958–2010	6.6%	0.4% – 12.9%

Source: Handley, An estimate of the historical equity risk premium for the period 1883 to 2010, January 2011, p. 8.

As is evident from the table, the relatively low estimates for the periods 1883-2010 and 1937-2010 are produced by a low estimate for the period 1937-1957. A simple calculation indicates that the mean excess return for this period was 4.8 per cent.⁵

³ AER, *Draft Decision. Envestra Ltd. Access Arrangement proposal for the SA gas network, 1 July 2011 – 30 June 2016*, February 2011.

⁴ Handley, J., *An estimate of the historical equity risk premium for the period 1883 to 2010*, January 2011, page 8.

⁵ The mean *MRP* from 1937 through 1957 is:

$$\frac{6.1 \times (2010 - 1936) - 6.6 \times (2010 - 1957)}{(1957 - 1936)} = 4.8 \text{ per cent}$$

The AER has acknowledged and Handley has been careful to make clear that the data from before 1958 are of a quality that is inferior to that of the data from 1958 through 2010. For example, Handley states that:⁶

‘there are sufficient question marks over the quality of data prior to 1958 to warrant any estimates based thereon to be treated with caution.’

Besides the issue of the quality of the data, though, it is also important to know whether the properties of the data have changed. In particular, since it is almost uniformly agreed that there should be a positive relation between risk and return, it is important to know whether the risk of the market portfolio has changed through time. This is because if the risk of the market portfolio computed from the earlier data were to be higher than the risk calculated from the later data, an estimate of the *MRP* that ignored this change would overestimate the current *MRP*. Similarly, if the risk of the market portfolio computed from the earlier data were to be lower than the risk calculated from the later data, an estimate of the *MRP* that ignored this change would underestimate the current *MRP*.

It is well known that the risk of the US market portfolio in pre-war data substantially exceeds the risk of the portfolio in post-war data. It is less well known that the risk of the Australian market portfolio – at least the measured risk – prior to around 1970 is substantially lower than the risk of the portfolio after 1970, as Kearns and Pagan (1993) clearly document.⁷ Kearns and Pagan do not provide an explanation for the behaviour but speculate that it may stem from the Australian market’s relative dependence on commodity prices, which the US market does not share. Figure 2.1 below updates their Figure 1.

We follow Kearns and Pagan and for each half decade use monthly without-dividend returns to estimate the variance of the monthly return to the Australian market portfolio.⁸ We use their estimates for the five years ending in December 1882 to the five years ending in December 1987 and update the series using estimates computed in an identical fashion for the five years ending December 1992 through to the five years ending in December 2007. Finally, we add an estimate of the monthly variance computed using the three years and three months from January 2008 through March 2011 to complete the series. The series that we draw from Kearns and Pagan and our updates to their series appear in Table A.1 in Appendix A.

Figure 2.1 makes clear that the earlier data have properties that differ substantially from those of the later data. As we note in Section 4, Merton (1973) provides a model in continuous time that under certain conditions implies that the *MRP* is proportional to the variance of the

⁶ Handley, J., *An estimate of the historical equity risk premium for the period 1883 to 2010*, January 2011, page 5.

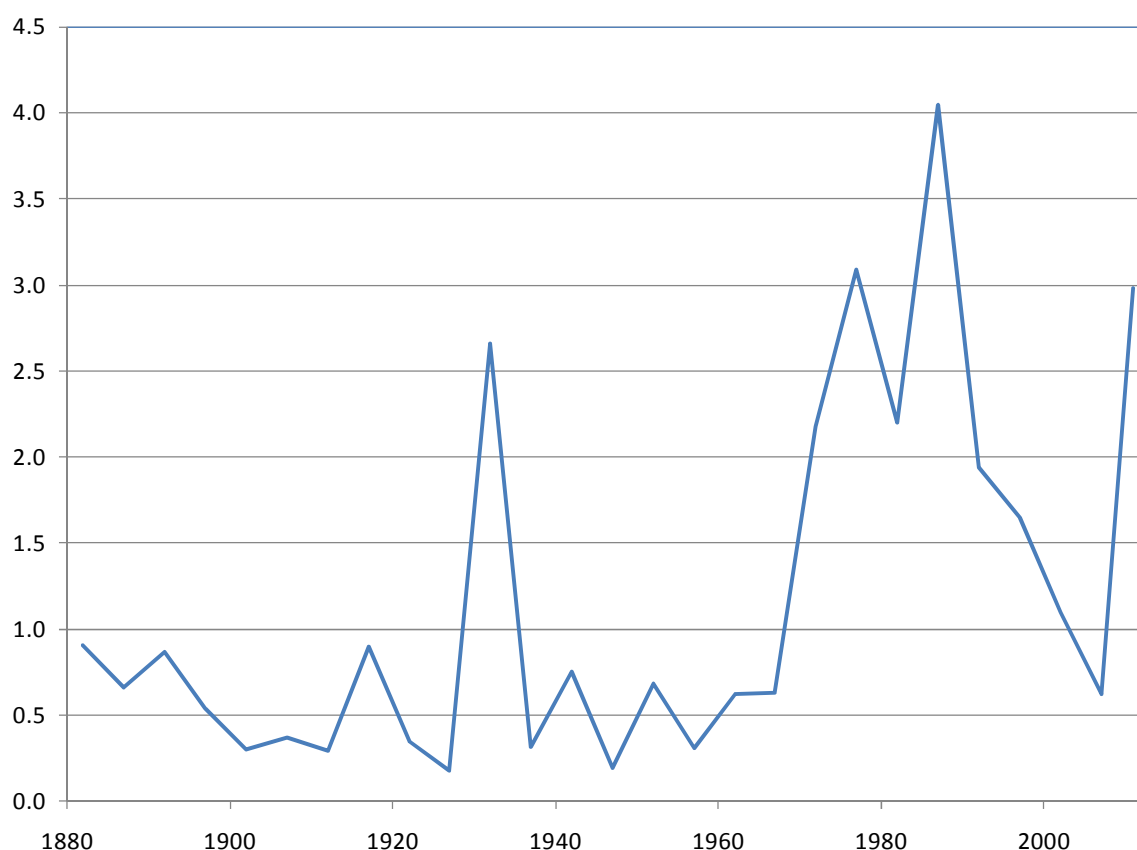
⁷ Kearns, P. and A. Pagan, Australian stock market volatility: 1875-1987. *Economic Record*, 69, 1993, pages 163-178.

⁸ Thus if r_t denotes the without-dividend return to the Australian market portfolio from the end of month $t-1$ to the end of month t , the five-year variance at the end of month t is:

$$\frac{1}{59} \sum_{j=1}^{60} (r_{t+1-j} - \bar{r})^2 \quad \text{where} \quad \bar{r} = \frac{1}{60} \sum_{j=1}^{60} r_{t+1-j}$$

return to the market portfolio.^{9, 10} The same conditions guarantee that the CAPM will hold instant by instant. While theory links the *MRP* to the variance of the return to the market portfolio, though, it may be easier to view a plot of the annualised volatility of returns against time. A plot of volatility against time appears as Figure 2.2 below.

Figure 2.1
Stock market variance by half decade



Note: Variance is multiplied by 10^3 . Data are from Kearns and Pagan (1993) before 1992 and are computed from the All Ordinaries Price Index thereafter.

The clear message from the two figures is that the data from before 1958 have very different properties to the data from after 1957. An estimate of the variance of the monthly return to the market computed by averaging the Kearns and Pagan five-year estimates from 1887 through 1957 is:¹¹

⁹ The conditions are that either it is not possible to hedge against changes in the investment opportunity set or that a representative investor does not wish to do so.

¹⁰ Merton, Robert C., *An intertemporal capital asset pricing model*, *Econometrica*, 1973, pages 867-887.

¹¹ Handley (2011) uses data from 1883 (= 1887 – 5 + 1) to construct estimates of the *MRP*.

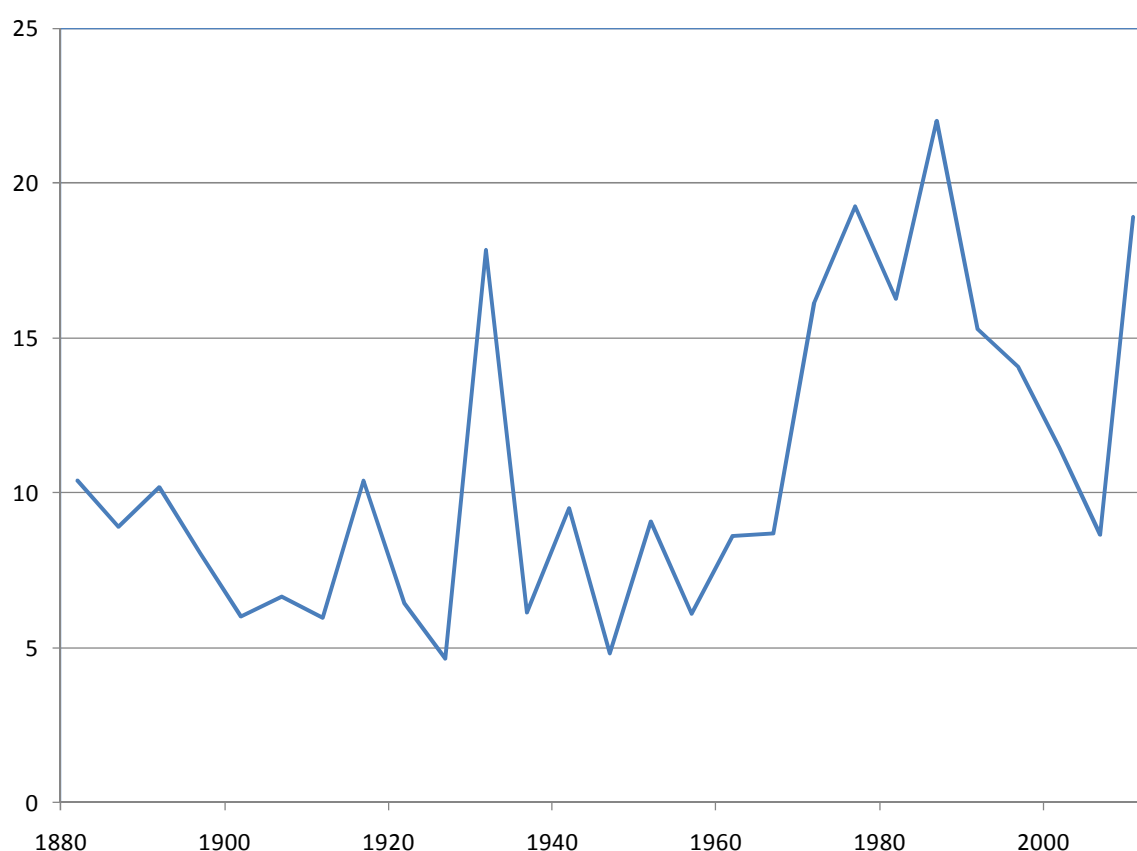
Handley, J., *An estimate of the historical equity risk premium for the period 1883 to 2010*, January 2011.

$$\frac{1}{15} \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2 = 0.62 \times 10^{-3}$$

where

$\hat{\sigma}_k^2$ = the variance of the monthly return to the market portfolio estimated over the five-year period ending in December of year k .

Figure 2.2
Stock market volatility by half decade



Note: Volatility is in per cent per annum but is based on monthly data. Data are from Kearns and Pagan (1993) before 1992 and are computed from the All Ordinaries Price Index thereafter.

The corresponding estimate computed using data from 1962 through 2011 is:

$$\frac{1}{10 \times (60 - 1) + (39 - 1)} \left[(60 - 1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39 - 1) \tilde{\sigma}_{2011}^2 \right] = 1.88 \times 10^{-3}$$

where

$\tilde{\sigma}_{2011}^2$ = the variance of the monthly return to the market portfolio estimated

over the 39 months ending in March 2011.

Thus an estimate of the variance of the return to the market portfolio after 1957 is three times an estimate of the variance of the return to the market portfolio before 1958. We do not have the complete time series of monthly returns used to generate Figure 2.1 and Figure 2.2, but, nevertheless, we can construct a test of the null hypothesis that the variance of the return to the market portfolio after 1957 is equal to the variance of the return to the market portfolio before 1958. We show in Appendix B that if monthly returns to the market portfolio are normally and independently distributed through time, then, under the null hypothesis, the ratio:

$$\frac{\left[(60-1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39-1) \tilde{\sigma}_{2011}^2 \right] / [10 \times (60-1) + (39-1)]}{\left[(60-1) \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2 \right] / [15 \times (60-1)]}$$

will be F distributed with $10 \times (60 - 1) + (39 - 1) = 628$ and $15 \times (60 - 1) = 885$ degrees of freedom. The numerator is an estimate of the variance of the return to the market portfolio computed using the 628 monthly observations after 1957 and the denominator is an estimate computed using the 885 observations before 1958. The ratio is $1.88 \div 0.62 = 3.00$ and the one per cent critical value for the $F_{628,885}$ distribution is 1.19. So one can reject the null at all conventional levels of significance. Thus the difference between the risks of the market portfolio after 1957 and before 1958 is both economically and statistically significant.

Since annualised volatilities can be easier to understand, we also compute annualised volatilities. After 1957, the annualised volatility of the return to the market portfolio is:

$$100 \times \sqrt{12 \times 1.88 \times 10^{-3}} = 15.01 \text{ per cent per annum}$$

while before 1958 the annualised volatility of the return to the market portfolio is:

$$100 \times \sqrt{12 \times 0.62 \times 10^{-3}} = 8.66 \text{ per cent per annum}$$

As Davis (2011) makes clear:¹²

‘a higher level of market volatility is likely to be associated with an increase in risk which translates into a higher *MRP*’

although he cautions that

‘the strength of the relationship is difficult to assess.’

This suggests that either:

¹² Davis, K., *Cost of equity issues: A Report for the AER*, January 2011, page 20.

- some upwards adjustment should be made to the data from 1883 through 1957 to reflect the lower risk of the Australian market portfolio;¹³ or
- if the strength of the relationship between volatility and the *MRP* proves too difficult to assess, the data from before 1958 should be discarded.

Either way it is likely that an estimate of the *MRP* will be computed to be at least 6.5 per cent per annum if not some way above. Again, the problem we see with relying so heavily on earlier data is that the evidence indicates that the market portfolio was less risky before 1958 than it has been after 1957. Thus one would expect that a representative investor would have required a lower premium on stocks before 1958 than after 1957. Including the earlier data should, if there is a positive relation between volatility and the *MRP*, depress estimates computed of the *MRP*.

There is, of course, nothing magical about the years 1957 and 1958. We choose these years because the estimates of the *MRP* that the AER reports use 1958 as a starting point for the most recent sub-period. One can, alternatively, allow the data to determine where changes in the volatility of the market portfolio occur.

Further, we do not view the Australian economy as being entirely segmented from world capital markets and we fully realize that the market portfolio of stocks is only part of the market portfolio of all risky assets. Thus the market risk premium attached to a portfolio of stocks will inevitably be determined not directly by the volatility of the market portfolio of stocks but by the covariance of the return to the portfolio with the return to some other portfolio that will likely include foreign assets and assets other than stocks. Changes in the volatility of the market portfolio of stocks, though, will very likely be positively correlated with changes in this covariance.

2.2 Current Conditions

The AER recognises that the *MRP* changes through time. However, while the AER uses a relatively clear process to determine how the risk-free rate should be computed, it does not provide a clear process to determine how the *MRP* should be computed.

There are a range of indicators that have been found to forecast the *MRP*. Among them are:

- the spread between the yields on BBB and AAA bonds; and, as we discuss later in Section 4; and
- the volatility of the return to the market portfolio implied by option prices.

Since we discuss the behaviour of implied volatility later in the report, we focus here on the behaviour of the default spread, that is, the spread between the yields on BBB and AAA bonds.

Keim and Stambaugh (1986) and Fama and French (1989) find that default spreads are positively related to the *MRP*.¹⁴ Similarly, Davis (2011) notes that:¹⁵

¹³ Unless one provide reliable evidence that the aversion to risk of a representative investor has fallen.

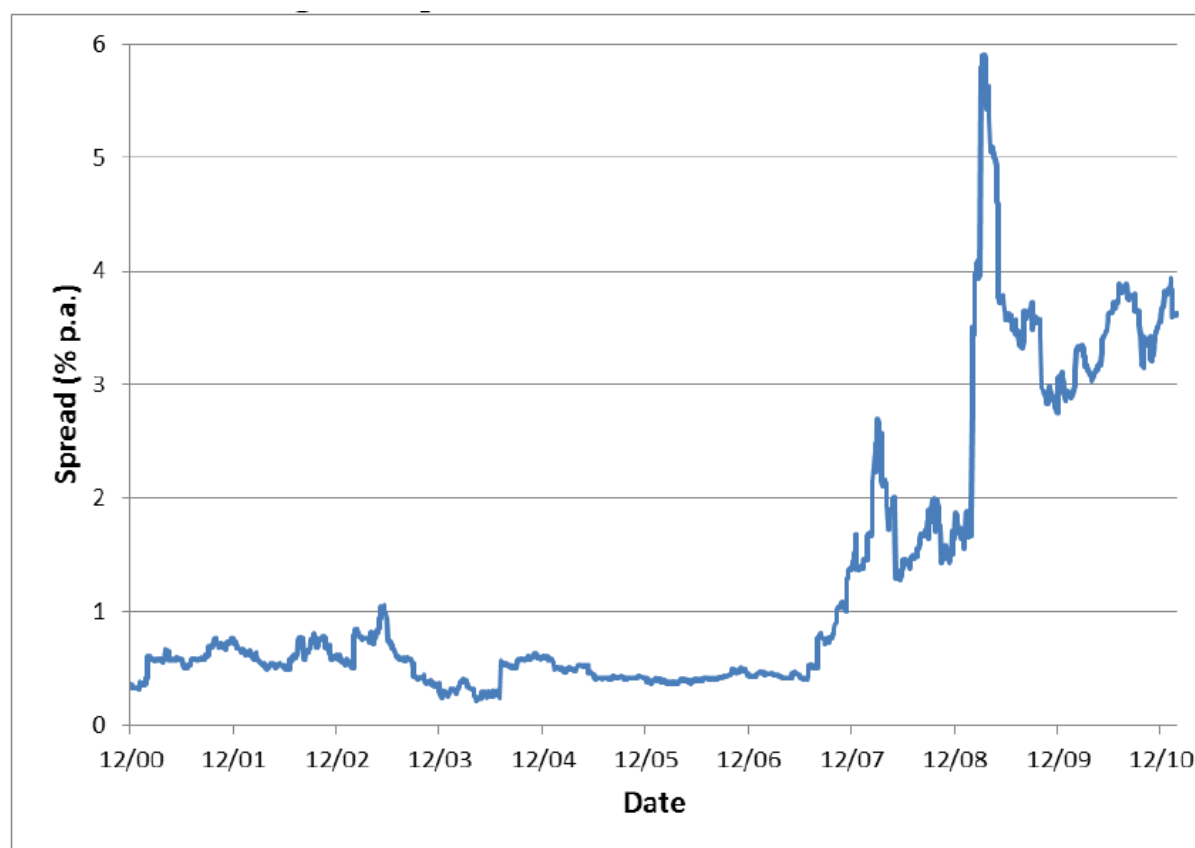
‘a higher spread is likely to be consistent with a higher *MRP*’

although he points out that:

‘the strength of the relationship in times of a financial crisis is difficult to assess.’

Figure 2.3 below reproduces a figure provided by SFG that plots the spread between BBB and AAA yields from 2000 to 2011 using data from Datastream.¹⁶

Figure 2.3
BBB-AAA yield spread



As can be seen from the figure, while the default spread has fallen from its peak during the worst of the Global Financial Crisis (GFC), it has not fallen back to anywhere near its pre-

¹⁴ Keim, D. And R. Stambaugh, *Predicting returns in the stock and bond markets*, Journal of Financial Economics, 1986, pages 357-390.

Fama, E. And K. French, *Business conditions and expected returns on stocks and bonds*, Journal of Financial Economics, 1989, pages 23-50.

¹⁵ Davis, K., *Cost of equity issues: A Report for the AER*, January 2011, page 20.

¹⁶ SFG, *Issues affecting the estimation of MRP: Report for Envestra*, March 2011, page 12.

GFC levels. Thus it is not clear why the AER has moved the *MRP* back to its pre-GFC levels. The justifications that the AER provides for doing so are that:¹⁷

‘the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD) and the Reserve Bank of Australia (RBA) ... indicate that the economic outlook for Australia has improved considerably’

and

‘recent survey based estimates of the *MRP* from Fernandez and Del Campo in May 2009 and May 2010 suggest that market views of the *MRP* did not significantly differ from those expressed prior to the onset of the GFC.’

While business conditions will surely have an impact on the *MRP*, it may not be business conditions in Australia that matter because Australia is a small open economy and its *MRP* will surely be determined in large part by business conditions worldwide. Business conditions in many other countries have not improved to the extent that Australian conditions have improved. Thus it is not clear to what extent an improvement in business conditions in Australia will have affected the *MRP* in Australia.

It is also worth noting that Kearns and Pagan (1993) point out that:¹⁸

‘From the 60s onward high volatility is apparent in Australian data largely independent of recessions, banking crises and so on. Perhaps, as is suggested above, this is attributable to the Australian market’s relative dependence on commodity prices, which the more diversified US market does not share.’

This suggests that the link between Australian business conditions and the Australian *MRP* may not be as close as the link between business conditions and the *MRP* in other countries.

The other rationale that the AER provides for lowering the *MRP* is that surveys by Fernandez and Del Campo suggest that the *MRP* has returned to pre-GFC levels. We examine these surveys in detail in the next section.

¹⁷ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, pages 81-85.

¹⁸ Kearns, P. And A. Pagan, *Australian stock market volatility:1987-1987*, Economic Record, page 177.

3 Survey Evidence

The AER argues that the evidence from surveys conducted by Fernández (2009) and Fernández and del Campo (2010) indicates that the *MRP* is 6 per cent per annum when it is adjusted for franking credits distributed.¹⁹ Fernández surveys academics while Fernández and del Campo survey practitioners about their views on a value for the *MRP*. The surveys they conduct are of individuals and institutions in many different countries and so the estimates they elicit are not about a single *MRP* but are instead about the expected excess returns associated with a large number of different indices, associated with countries whose capital markets may or may not be fully integrated with one another, denominated in a large number of different currencies.

In this section we examine the AER's argument. In particular, we examine the argument that the evidence indicates that the responders to the surveys adjust for credits distributed. To begin with, though, we discuss the merits of survey evidence.

3.1 Merits of Survey Evidence

Some well-known problems with surveys are that:

- while the recipients may be randomly selected or selected using some scheme that targets particular individuals or institutions, responders self select – in particular responders can be individuals who place a lower value on their time than non-responders;
- it is difficult to provide recipients with an appropriate incentive to respond accurately and in an unbiased manner; and
- the responses elicited can depend on how the survey questions are phrased.

Fernández (2009) reports that of 7,500 recipients of his survey of academics, 1,309 responded.²⁰ Thus 83 per cent of academic recipients did not respond. Fernández and del Campo (2010) report that of 8,500 recipients of his survey of practitioners, 2,460 responded.²¹ Thus 71 per cent of practitioner recipients did not respond. A concern with the large number of non-respondents is that the respondents may differ in some systematic way from the non-respondents.

Fernández (2009) reports that 23 Australian academics responded to his survey while Fernández and del Campo (2010) report that 7 Australian analysts responded to their

¹⁹ Fernandez P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009.

Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010.

²⁰ Fernandez, P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009, page 2.

²¹ Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 2.

survey.²² Thus the sample of Australian academics and analysts on which the two authors rely are small.

Since none of the academic responders are placing their careers on the line, it is difficult to know how seriously to take the responses. If an academic uses an *MRP* that is too high or too low to illustrate to a class how the CAPM works, he or she will bear essentially no cost. This is because even if the academic is using a case study – and many academics do not use case studies – he or she will not face a cost if, for example, he or she accepts a negative-NPV project. Many academics will see their role as being to teach students how the CAPM works and not to tell students precisely what inputs to use.

The evidence that Fernández (2009) provides suggests that many academic responders take as an estimate of the *MRP* a figure drawn from one of a small number of textbooks. Thus the survey responses may be far from independent of one another. It is also not clear when academic responders cite a text as a reference that they have examined whether the *MRP* figure provided by the text is reasonable. It may well be that they have not considered the appropriateness of the *MRP* figure in depth but they like the text for other reasons and so are happy to use the particular value that the text provides.

Similarly, none of the practitioner responders are placing their careers on the line, so it is also difficult to know how seriously to take their responses. The practitioner responders will bear no cost if they provide responses that are either too high or too low.

The evidence that Fernández and del Campo (2010) provide indicates that one of the seven Australian analysts who were kind enough to respond to their survey stated that:²³

‘In Australia, there are a significant number of regulatory decisions, which use the CAPM framework and go through a public consultation process. There are a significant number of submissions made on CAPM with expert opinions provided.’

Thus it is not clear that much is to be learnt from at least one of the seven Australian analysts who responded to the survey. This is because it is not clear whether the analyst thought carefully about whether the public consultation process has in the past arrived at a reasonable figure for the *MRP* or whether the consultation process provided the analyst with a number that could be plugged quickly into a response so as to clear his or her email inbox and prevent the analyst from receiving further unsolicited emails.

²² Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 14.

²³ Fernandez P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009, page 5.

Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 4.

3.2 Importance of Franking Credits

The AER assumes that the market value of a one dollar credit distributed is 65 cents, although it is far from clear that this figure is what the evidence on the value of credits distributed implies.²⁴ The current yield on the ASX 200 is around 4 per cent while the corporate tax rate is 30 per cent. So if we follow Brailsford, Handley and Maheswaran (2008) and assume that 75 per cent of dividends distributed are franked, the value to the market of credits distributed, with these figures, must be:²⁵

$$0.65 \times 0.75 \times \frac{0.30}{1 - 0.30} \times 4 = 0.84 \quad (1)$$

Thus, with these figures, an adjustment for credits distributed is of the order of 84 basis points, which, relative to an *MRP* of 6 per cent, is a significant number. For example, it is almost twice as large as the upward revision of the *MRP* from 6 to 6.5 per cent per annum that the AER provided in 2008 and the downward revision from 6.5 to 6 per cent per annum that the AER has recommended in 2011.

3.3 Surveys and Imputation

The survey question that Fernández (2009) posed contains no mention of franking or imputation credits or of taxes. Similarly, the survey question that Fernández and del Campo (2010) posed contains no mention of franking or imputation credits or of taxes. The two survey questions are shown below in Figure 3.1 and Figure 3.2.²⁶

To examine whether the surveys carried out by Fernández (2009) and Fernández and del Campo (2010) provide estimates of the *MRP* for Australia that either take into account franking credits or do not take into account franking credits, we conducted a search of the two papers using a number of keywords.

First, we conducted a search of the two papers using the keyword: imputation. A search of Fernández (2009) provided no hits but a search of Fernández and del Campo (2010) provided the following passage from an analyst responder:²⁷

‘Possibly an area where a practitioner like me would benefit is whether it makes sense to use different *MRP* estimates as economic conditions change and/or the use of ranges for cost of capital estimates for valuations/ capital budgeting/ performance measurement etc. The long run historical average seems almost

²⁴ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, page 104.

²⁵ Brailsford, T., J. Handley and K. Maheswaran, *Re-examination of the historical equity risk premium in Australia*, Accounting and Finance 48, 2008, page 85.

²⁶ Fernandez P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009, page 12.

Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 11.

²⁷ Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 13.

meaningless when one looks at both the standard error of the estimate (7.5% imputation adjusted average with a[n] SE of 23%) and at the ranges/volatility of annual estimates.’

Figure 3.1
Survey question posed by Fernández (2009)

EXHIBIT 1. Mail sent on January 2009

I am doing a survey about the Market Risk Premium that we, professors, use to calculate the required return to equity.

I will be very grateful to you if you kindly reply to the following 3 questions.

Of course, no individuals or schools will be identified and only aggregate data will be made public.

Best regards and thanks,

Pablo Fernández. IESE Business School. Spain

3 questions:

1. The Market Risk Premium that I used in 2008 was %

2. I justify this number:

I do not justify the number

Reference to books or articles

Which ones?:

<input type="text"/>
<input type="text"/>

3. In previous years, I used different premia

year	premium	
2007	<input type="text"/>	%
<input type="text"/>	<input type="text"/>	%
<input type="text"/>	<input type="text"/>	%

Comments

Interestingly, this analyst responder provides in his or her comment an imputation-adjusted estimate of the *MRP* of 7.5 per cent while Table 4 of Fernández and del Campo (2010) reports that the maximum *MRP* reported by Australian respondents is 6 per cent.²⁸ This implies that, for at least this responder, his or her response of, presumably 6 per cent, was imputation credit unadjusted.

Second, we conducted a search of the two papers using the keyword: franking. No matches were found in either paper.

Third, we conducted a search of the two papers using the keyword: credit. This turned up a single reference in Fernández (2009) citing credit spreads as a guide to the *MRP*.²⁹

²⁸ Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 4.

²⁹ Fernandez P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009, page 20.

‘France. The *MRP* is as volatile as the market. There are other sources of measures for risk aversion such as credit spreads.’

We conclude that there is no evidence that the estimates of the *MRP* for Australia tabulated by Fernández (2009) and Fernández and del Campo (2010) are imputation-adjusted. Instead, a single piece of evidence suggests that the *MRP* estimates are not adjusted.

Figure 3.2 Survey question posed by Fernández and del Campo (2010)

EXHIBIT 1. Mail sent on April and May 2010

I am doing a survey about the Market Risk Premium (MRP) that companies, analysts and professors use to calculate the required return to equity in different countries.
I will be very grateful to you if you kindly reply to the following 3 questions.
Of course, no individuals, universities or companies will be identified and only aggregate data will be made public.

Best regards and thanks,
Pablo Fernandez
Professor of Finance. IESE Business School. Spain

3 questions:

1. The Market Risk Premium that I am using in 2010 is: _____ %
2. Books or articles that I use to support this number:
3. Last year, I used a different MRP: _____ %

Comments

Under the assumption that the survey data are not imputation adjusted, the presumed unadjusted mean estimate of 5.9 per cent reported by Fernández (2009) from 23 Australian academics corresponds to an imputation-adjusted estimate of 6.7 per cent.³⁰ Under the assumption that the survey data are not imputation adjusted, the presumed unadjusted mean estimate of 5.4 per cent reported by Fernández and del Campo (2010) from seven Australian analysts corresponds to an imputation-adjusted estimate of 6.2 per cent.³¹ A responder-weighted average of these imputation-adjusted estimates drawn from the two papers is:

$$\frac{23}{23+7} \times 6.7 + \frac{7}{23+7} \times 6.2 = 6.6 \text{ per cent} \quad (2)$$

³⁰ Fernandez P., *Market risk premium used by professors in 2008: A survey with 1400 answers*, IESE Business School Working Paper, WP-796, May 2009, page 2.

³¹ Fernandez, P. and J. Del Campo, *Market risk premium used in 2010 by analysts and companies: A survey with 2400 answers*, IESE Business School, May 21 2010, page 4.

4 Implied Volatility as a Predictor of the *MRP*

In this section we evaluate the argument that Bishop and Officer (2010) make that implied volatility tracks the *MRP* and the counter argument that the AER makes that:^{32, 33}

‘the significant variability in the short term *MRP* derived from implied volatility measures makes such estimates an unreliable source of evidence when setting a *MRP* for a 10-year investment horizon.’

4.1. Theory

Intuition suggests that risk and return must be related not just across assets but also across time. Merton (1973) shows that the conditions which allow the CAPM to hold instant by instant are also the conditions which guarantee that a simple relation exists between the *MRP* and the volatility of the return to the market portfolio.^{34, 35} From equation (19) of his paper:

$$MRP = R \sigma_m^2, \quad (3)$$

where

R = relative risk aversion, a measure of the aversion to risk of a representative investor; and

σ_m^2 = the variance of the return to the market portfolio, that is, the square of the volatility of the return.

This simple relation states that the *MRP* will be higher the more averse to risk is a representative investor and the more volatile is the return to the market portfolio. Moreover, the relation guarantees that the *MRP* can never be negative. This is because a representative investor is averse to risk and the variance of the return to the market portfolio can never be negative. In contrast, forecasts generated by other models can generate forecasts of the *MRP* that are negative if not constrained.

The link provided by equation (3) suggests that one should find:

- a positive relation between forecast volatility and subsequent returns; and
- a negative contemporaneous relation between innovations in volatility and returns.

³² Bishop S. And R. Officer, *Market risk premium, Comments on the AER draft distribution determination for Victorian electricity distribution network service providers*, July 2010.

³³ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, page 263.

³⁴ The conditions are that either it is not possible to hedge against changes in the investment opportunity set or that a representative investor does not wish to do so.

³⁵ Merton, Robert C., *An intertemporal capital asset pricing model*, *Econometrica*, 1973, pages 867-887.

The second of these predictions arises because an unexpected increase in volatility will raise the *MRP* and so depress equity prices. An innovation or unexpected change in volatility is defined to be the difference between realized and forecast volatility. Testing for these links faces the problem that the return to the market portfolio is unobservable. However, the problem will be surmountable if:

- the risk of the market portfolio of equities is positively correlated through time with the risk of the entire market portfolio; and
- no theoretical restriction is placed on the value of the relative risk aversion of a representative investor.

Two methods have been employed to forecast volatility. First, forecasts have been generated using time series of returns. Second, forecasts have been backed out of option prices.

French, Schwert and Stambaugh (1987) are the first authors to examine the relation between the *MRP* and forecasts of volatility generated using time series of returns.³⁶ They summarize their results in the following way:

‘We find evidence that the expected market risk premium (the expected return on a stock portfolio minus the Treasury bill yield) is positively related to the predictable volatility of stock returns. There is also evidence that unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns.’

Other authors have found a weaker relation between the *MRP* and forecast volatility but the negative contemporaneous relation between unexpected changes in volatility and returns appears to be robust to the use of different data and different estimation methods.³⁷

A natural alternative to generating forecasts of volatility from time series of returns is to back out forward looking forecasts of volatility from option prices. These measures are called implied volatilities. They are typically generated using a version of the Black-Scholes option pricing model and at-the-money (ATM) calls or puts.

4.2. Link Between Implied Volatility and Realised Volatility

The AER in its Draft Decision suggests that implied volatility is not useful for forecasting future volatility. For example, it states that:³⁸

‘Chernov studied the role of risk premia in volatility forecasting and explained why at-the-money option implied volatility is a biased and inefficient forecast of future realised volatility.’

³⁶ French, K., G.W. Schwert and R. Stambaugh, Expected stock returns and volatility, *Journal of Financial Economics*, 1987, pages 3-29.

³⁷ Unexpected changes in volatility are often measured using time series models pioneered by Nobel Prize winner Robert Engle. Among these models are the Autoregressive Conditional Heteroscedasticity (ARCH) and Generalised Autoregressive Conditional Heteroscedasticity (GARCH) models.

³⁸ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, page 262.

What Chernov (2007) actually said was that from a survey of the literature:³⁹

‘A number of robust conclusions have emerged: ATM implied volatility is (1) informative about future volatility, (2) superior to other measures of volatility, and (3) an upward-biased predictor.’

In other words, Chernov summarized the evidence as indicating that there is a positive relation between implied volatility and future volatility and that implied volatility better forecasts future volatility than other measures. Similarly, Blair, Poon and Taylor (2001) find that:⁴⁰

‘The in-sample estimates show that nearly all relevant information is provided by the VIX index and hence there is not much incremental information in high-frequency index returns. For out-of-sample forecasting, the VIX index provides the most accurate forecasts for all forecast horizons and performance measures considered.’

The VIX is the ticker symbol for the Chicago Board Options Exchange Market Volatility Index, a measure of the implied volatility of the S & P 500 index.

Guo and Whitelaw (2006) also report the same sort of results.⁴¹ They conclude that:⁴²

‘it is clear that implied variance is the best single predictor [of realized volatility] and that little is lost by excluding the other explanatory variables. Consequently, we select the implied variance as the single explanatory variable in the variance equation.’

The fact that implied volatility provides an upwardly biased forecast of future volatility, while of interest, need not generate a significant problem for forecasting if forecasts of future volatility can be adjusted for the bias. Guo and Whitelaw (2006), for example, adjust for the bias. They state that:⁴³

‘If implied variance is a conditionally unbiased predictor of future variance, then in Table I the intercept in the last regression should be equal to zero and the coefficient on implied variance should be equal to one. However, an extensive literature documents positive intercepts and slopes less than unity in similar regressions ... Table I shows that while the estimated coefficient is positive, it is significantly less than one, and the intercept is significantly positive, although it is small. Thus, while implied volatility may be informationally efficient relative to other variables it is not conditionally unbiased. As a result, we use the fitted value

³⁹ Chernov, M., *On the role of risk premia in volatility forecasting*, Journal of Business and Economic Statistics, 2007, page 411.

⁴⁰ Blair, B., Poon, S.-H., and Taylor, S. (2001), “Forecasting S&P 500 Volatility: The Incremental Information Content of Implied Volatilities and High-Frequency Index Returns,” *Journal of Econometrics*, 105, 5–26.

⁴¹ Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, *Journal of Finance*, 2006, pages 1433-1463.

⁴² Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, *Journal of Finance*, 2006, page 1446.

⁴³ Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, *Journal of Finance*, 2006, page 1446.

from this estimation as our proxy for conditional variance in the estimation of the full model.’

4.3. Implied Volatility and the *MRP*

Tests for a relation between implied volatility and the *MRP* find a positive relation between the two. Guo and Whitelaw (2006), for example, using the VIX as a measure of risk, and data from 1984 through 2001 summarize their results in the following way: ⁴⁴

‘Model 1 is the standard risk-return model estimated in much of the literature, that is, a regression of returns on a measure of the conditional variance. However, in contrast to many existing results, we find a coefficient that is positive, albeit statistically insignificant, and reasonable in magnitude. If the hedge component is unimportant or orthogonal to the risk component, the coefficient value of 2.5 represents an estimate of the coefficient of relative risk aversion of the representative agent; however, this estimate may be biased downwards slightly due to measurement error in the conditional variance.’

Further tests that they conduct reveal that other measures of risk help to explain the time series behaviour of returns. In other words, like many others, Guo and Whitelaw find evidence against the CAPM.

Banerjee, Doran and Peterson (2007), on the other hand, using data from 1987 through 2005 find a significant positive relation between the VIX and future S & P 500 returns in excess of the risk-free rate. ⁴⁵ They state that: ⁴⁶

‘Before testing the characteristic portfolios, we examine if VIX levels and innovations predict future market excess returns. To test this hypothesis, and confirm the results in Giot (2005), the 30-day and 60-day excess returns on the S&P 500 are regressed on the VIX variables.¹⁵ The regressions are identical to those in Eqs. (17a) and (17b), except the dependent variable is the return on the S&P 500. The results are reported in Table 1 and show significantly positive coefficients on the VIX level at the 5% level. They are not surprising and consistent with prior findings related to VIX and future returns.’

The difference between the results of Guo and Whitelaw (2006) and Banerjee, Doran and Peterson (2007) must stem from their use of different time periods because there is little difference in the specifications that they use. Despite the difference between the results, the two pieces of evidence, particularly the second piece of evidence, suggest that there is some support for a link between the *MRP* and a measure of implied volatility.

⁴⁴ Guo, H. And R. Whitelaw, Uncovering the risk-return relation in the stock market, Journal of Finance, 2006, page 1448.

⁴⁵ Doran, J., P. Banerjee and D. Peterson, Implied volatility and future portfolio returns, Journal of Banking and Finance, 2007, pages 3183–3199.

⁴⁶ Doran, J., P. Banerjee and D. Peterson, Implied volatility and future portfolio returns, Journal of Banking and Finance, 2007, page 3190.

4.4. Current Market Conditions

Figure 4.1 below plots the volatility implied by a three-month call option on the ASX 200 index against time. The volatility is from Citigroup and is the volatility implied by a three-month call option on the ASX 200. An examination of the figure shows that this measure of implied volatility, while well below its peak reached during the midst of the Global Financial Crisis (GFC), is nevertheless at a level that is twice the value at which it sat during the period from 2004 through 2006. This suggests that while the *MRP* may be below the level it reached during the worst of the GFC, it is above the level at which it sat during much of the last decade.

Figure 4.1
Volatility implied by a three-month call option on the ASX 200



Note: Data is sourced from Bloomberg under the code CITJAVIX.

Interestingly, the figure provides dramatic evidence against the AER's proposition that in general:⁴⁷

'the significant variability in the short term *MRP* derived from implied volatility measures makes such estimates an unreliable source of evidence when setting a *MRP* for a 10-year investment horizon.'

The figure shows that there are prolonged swings in the implied volatility series away from its mean. The figure also shows, of course, that the index is mean reverting. Thus swings away from the mean tend to be reversed over time.

4.5. Other Models

Finally, the ability of implied volatility to forecast the *MRP* does not rule out the existence of alternative methods of extracting information from option prices in order to forecast the *MRP*. Nor does the existence of alternative methods of extracting information from option prices in order to forecast the *MRP* imply that one cannot use implied volatility to forecast the *MRP*.

As the AER notes, Santa-Clara and Yan (2010) find, using data from 1996 through 2002, that a measure of the *MRP* extracted from option prices under the assumption that stock prices experience jumps – something that the Black-Scholes model rules out – is useful for predicting the *MRP*.⁴⁸ Their evidence, though, does not rule out the use of implied volatility to forecast *MRP*. It may, though, indicate that there are better ways of extracting information from option prices.

⁴⁷ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, page 263.

⁴⁸ AER, *Envestra Ltd Access arrangement proposal for the Qld gas network, 1 July 2011 – 30 June 2016: Draft Decision*, February 2011, page 262.

Santa-Clara, P. and S. Yan, *Crashes, volatility, and the equity premium lessons from S&P options*, Review of Economics and Statistics, 2010, pages 435-451.

5 Conclusions

This report has been prepared for Multinet Gas and SP AusNet by NERA Economic Consulting (NERA). Multinet Gas and SP AusNet have asked NERA to examine a number of issues that arise from the recently published *Envestra Ltd Access arrangement proposal for the SA gas network, 1 July 2011 – 30 June 2016: Draft Decision* provided by the Australian Energy Regulator (AER).

In particular, Multinet Gas and SP AusNet have asked NERA to assess:

- whether the historical evidence indicates that a long-term average market risk premium (*MRP*) of 6 per cent per annum inclusive of the value of imputation credits is appropriate;
- whether current conditions warrant an *MRP* at its long-term average or above its long-term average;
- whether the survey papers of Fernández (2009) and Fernández and del Campo (2010) to which the AER refers provide support for an *MRP* of 6 per cent per annum inclusive of the value of imputation credits; and
- whether the volatility of the return to the market portfolio implied by option prices can provide a guide as to the *MRP*.

We document that:

- the historical evidence indicates that the Australian market portfolio was substantially less risky in the later part of the 19th century and the earlier part of the 20th century than in the later part of the 20th century and the start of the 21st century. The variance of the return to the Australian market portfolio has been *three times* as high in the later period than in the earlier period. This empirical result casts considerable doubt on the wisdom of the AER's decision to combine, without any adjustment for differences in risk, data from the earlier period with data from the later period in order to estimate the *MRP*. Either adjusting the earlier data or throwing out the earlier data will lead to an *MRP* of at least 6.5 per cent per annum;
- current conditions suggest that the *MRP* is above its long-term average. The spread between BBB bond yields and AAA bond yields, while lower than during the worst of the Global Financial Crisis, is still *well above* its long-run average. Also the volatility of the return to the Australian market portfolio implied by option prices suggests that the risk of the market sits at a level that is above where it sat for much of the last decade;
- the survey papers of Fernández (2009) and Fernández and del Campo (2010) provide little information about whether responders are measuring the Australian *MRP* inclusive or exclusive of imputation credits. The only piece of evidence pertaining to the issue in the papers indicates that responders are measuring the *MRP exclusive* of imputation credits. A weighted average of the Australian responses adjusted for the value of imputation credits indicates that inclusive of the value of imputation credits the *MRP* is at least 6.5 per cent per annum;
- there is evidence in the literature that the volatility of the return to the market portfolio implied by option prices *can* provide a guide as to the *MRP*. In addition, the implied volatility of stock market returns, inferred from option prices, is a reasonable predictor of

future volatility. The AER has misinterpreted the results of a study by Chernov (2007) which actually suggests that there is information about future volatility contained in implied volatility;⁴⁹ and

- the literature also documents, consistent with the existence of a positive link between expected volatility and the *MRP*, that there is a negative relation between unexpected changes in volatility and the return to the market portfolio.

⁴⁹ Chernov, M., *On the role of risk premia in volatility forecasting*, Journal of Business and Economic Statistics, 2007, page 411.

Appendix A. Data

This appendix provides the data used to construct Figure 2.1 and Figure 2.2 that appear in Section 2.

Table A.1
Volatility data

Half decade ending	Variance $\times 10^3$	Volatility
1882	0.904	10.414
1887	0.664	8.924
1892	0.866	10.196
1897	0.539	8.043
1902	0.301	6.007
1907	0.368	6.643
1912	0.296	5.964
1917	0.898	10.379
1922	0.347	6.450
1927	0.181	4.654
1932	2.656	17.854
1937	0.316	6.157
1942	0.756	9.523
1947	0.192	4.805
1952	0.686	9.071
1957	0.310	6.094
1962	0.620	8.628
1967	0.629	8.686
1972	2.174	16.153
1977	3.090	19.257
1982	2.201	16.251
1987	4.041	22.022
1992	1.942	15.266
1997	1.649	14.067
2002	1.098	11.479
2007	0.622	8.639
2011	2.980	18.910

Notes: The variance of monthly returns has been multiplied by 10^3 while the volatility is in per cent has been annualised by multiplying by $\sqrt{12}$. Data from before 1992 are from Kearns and Pagan (1993). Data from after 1987 are computed using the All Ordinaries Price Index.

Appendix B. F-test

This appendix shows that if monthly returns to the market portfolio are normally and independently distributed through time, then, under the null hypothesis that the variance of the return to the market portfolio after 1957 is equal to the variance of the return to the market portfolio before 1958, the ratio:

$$\frac{\left[(60-1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39-1) \tilde{\sigma}_{2011}^2 \right] / [10 \times (60-1) + (39-1)]}{\left[(60-1) \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2 \right] / [15 \times (60-1)]}$$

will be F distributed with $10 \times (60-1) + (39-1) = 628$ and $15 \times (60-1) = 885$ degrees of freedom.

Let r_t denote the without-dividend return to the Australian market portfolio from the end of month $t-1$ to the end of month t and let

$$r_t \sim N(\mu_1, \sigma_1^2)$$

before 1958 and

$$r_t \sim N(\mu_2, \sigma_2^2)$$

after 1957. Then⁵⁰

$$\frac{(60-1)\hat{\sigma}_k^2}{\sigma_1^2} \sim \chi_{(60-1)}^2$$

before 1958 and

$$\frac{(60-1)\hat{\sigma}_k^2}{\sigma_2^2} \sim \chi_{(60-1)}^2$$

after 1957, where, again,

$$\hat{\sigma}_k^2 = \text{the variance of the monthly return to the market portfolio estimated over the five-year period ending in December of year } k.$$

Similarly,

⁵⁰ Freund, J.E., *Mathematical statistics*, Prentice-Hall, 1972, page 214.

$$\frac{(39-1)\tilde{\sigma}_{2011}^2}{\sigma_2^2} \sim \chi_{(39-1)}^2$$

where, again,

$\tilde{\sigma}_{2011}^2$ = the variance of the monthly return to the market portfolio estimated over the 39 months ending in March 2011.

The sum of a random variable that is chi-square distributed with n_1 degrees of freedom and an independent random variable that is chi-square distributed with n_2 degrees of freedom must be chi-square distributed with $n_1 + n_2$ degrees of freedom.⁵¹ So it follows that

$$\frac{(60-1) \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2}{\sigma_1^2} \sim \chi_{885}^2$$

and

$$\frac{\left[(60-1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39-1) \tilde{\sigma}_{2011}^2 \right]}{\sigma_2^2} \sim \chi_{628}^2$$

The ratio of a random variable that is chi-square distributed with n_1 degrees of freedom, divided by its degrees of freedom n_1 , to an independent random variable that is chi-square distributed with n_2 degrees of freedom, divided by its degrees of freedom n_2 , is F distributed with n_1 and n_2 degrees of freedom.⁵² Thus

$$\left[\frac{\sigma_1^2}{\sigma_2^2} \right] \frac{\left[(60-1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39-1) \tilde{\sigma}_{2011}^2 \right] / [10 \times (60-1) + (39-1)]}{\left[(60-1) \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2 \right] / [15 \times (60-1)]} \sim F_{628,885}$$

It follows that under the null hypothesis that the variance of the return to the market portfolio after 1957 is equal to the variance of the return to the market portfolio before 1958, the ratio:

⁵¹ Freund, J.E., *Mathematical statistics*, Prentice-Hall, 1972, page 213.

⁵² Freund, J.E., *Mathematical statistics*, Prentice-Hall, 1972, page 219.

$$\frac{\left[(60-1) \sum_{j=1}^{10} \hat{\sigma}_{1962+5(j-1)}^2 + (39-1) \hat{\sigma}_{2011}^2 \right] / [10 \times (60-1) + (39-1)]}{\left[(60-1) \sum_{j=1}^{15} \hat{\sigma}_{1887+5(j-1)}^2 \right] / [15 \times (60-1)]}$$

will be F distributed with $10 \times (60 - 1) + (39 - 1) = 628$ and $15 \times (60 - 1) = 885$ degrees of freedom.

Appendix C. Expert Witness Guidelines

Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia

Practice Direction

This replaces the Practice Direction on Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia issued on 6 June 2007.

Practitioners should give a copy of the following guidelines to any witness they propose to retain for the purpose of preparing a report or giving evidence in a proceeding as to an opinion held by the witness that is wholly or substantially based on the specialised knowledge of the witness (see - **Part 3.3 - Opinion** of the *Evidence Act 1995* (Cth)).

M.E.J. BLACK

Chief Justice

5 May 2008

Explanatory Memorandum

The guidelines are not intended to address all aspects of an expert witness's duties, but are intended to facilitate the admission of opinion evidence (footnote #1), and to assist experts to understand in general terms what the Court expects of them. Additionally, it is hoped that the guidelines will assist individual expert witnesses to avoid the criticism that is sometimes made (whether rightly or wrongly) that expert witnesses lack objectivity, or have coloured their evidence in favour of the party calling them.

Ways by which an expert witness giving opinion evidence may avoid criticism of partiality include ensuring that the report, or other statement of evidence:

- (a) is clearly expressed and not argumentative in tone;
- (b) is centrally concerned to express an opinion, upon a clearly defined question or questions, based on the expert's specialised knowledge;
- (c) identifies with precision the factual premises upon which the opinion is based;
- (d) explains the process of reasoning by which the expert reached the opinion expressed in the report;
- (e) is confined to the area or areas of the expert's specialised knowledge; and

- (f) identifies any pre-existing relationship (such as that of treating medical practitioner or a firm's accountant) between the author of the report, or his or her firm, company etc, and a party to the litigation.

An expert is not disqualified from giving evidence by reason only of a pre-existing relationship with the party that proffers the expert as a witness, but the nature of the pre-existing relationship should be disclosed.

The expert should make it clear whether, and to what extent, the opinion is based on the personal knowledge of the expert (the factual basis for which might be required to be established by admissible evidence of the expert or another witness) derived from the ongoing relationship rather than on factual premises or assumptions provided to the expert by way of instructions.

All experts need to be aware that if they participate to a significant degree in the process of formulating and preparing the case of a party, they may find it difficult to maintain objectivity.

An expert witness does not compromise objectivity by defending, forcefully if necessary, an opinion based on the expert's specialised knowledge which is genuinely held but may do so if the expert is, for example, unwilling to give consideration to alternative factual premises or is unwilling, where appropriate, to acknowledge recognised differences of opinion or approach between experts in the relevant discipline.

Some expert evidence is necessarily evaluative in character and, to an extent, argumentative. Some evidence by economists about the definition of the relevant market in competition law cases and evidence by anthropologists about the identification of a traditional society for the purposes of native title applications may be of such a character. The Court has a discretion to treat essentially argumentative evidence as submission, see Order 10 paragraph 1(2)(j).

The guidelines are, as their title indicates, no more than guidelines. Attempts to apply them literally in every case may prove unhelpful. In some areas of specialised knowledge and in some circumstances (eg some aspects of economic evidence in competition law cases) their literal interpretation may prove unworkable.

The Court expects legal practitioners and experts to work together to ensure that the guidelines are implemented in a practically sensible way which ensures that they achieve their intended purpose.

Nothing in the guidelines is intended to require the retention of more than one expert on the same subject matter – one to assist and one to give evidence. In most cases this would be wasteful. It is not required by the Guidelines. Expert assistance may be required in the early identification of the real issues in dispute.

Guidelines

1. General Duty to the Court (footnote #2)

- 1.1 An expert witness has an overriding duty to assist the Court on matters relevant to the expert's area of expertise.

- 1.2 An expert witness is not an advocate for a party even when giving testimony that is necessarily evaluative rather than inferential (footnote #3).
- 1.3 An expert witness's paramount duty is to the Court and not to the person retaining the expert.

2. The Form of the Expert Evidence (footnote #4)

- 2.1 An expert's written report must give details of the expert's qualifications and of the literature or other material used in making the report.
- 2.2 All assumptions of fact made by the expert should be clearly and fully stated.
- 2.3 The report should identify and state the qualifications of each person who carried out any tests or experiments upon which the expert relied in compiling the report.
- 2.4 Where several opinions are provided in the report, the expert should summarise them.
- 2.5 The expert should give the reasons for each opinion.
- 2.6 At the end of the report the expert should declare that "[the expert] has *made all the inquiries that [the expert] believes are desirable and appropriate and that no matters of significance that [the expert] regards as relevant have, to [the expert's] knowledge, been withheld from the Court.*"
- 2.7 There should be included in or attached to the report; (i) a statement of the questions or issues that the expert was asked to address; (ii) the factual premises upon which the report proceeds; and (iii) the documents and other materials that the expert has been instructed to consider.
- 2.8 If, after exchange of reports or at any other stage, an expert witness changes a material opinion, having read another expert's report or for any other reason, the change should be communicated in a timely manner (through legal representatives) to each party to whom the expert witness's report has been provided and, when appropriate, to the Court (footnote #5).
- 2.9 If an expert's opinion is not fully researched because the expert considers that insufficient data are available, or for any other reason, this must be stated with an indication that the opinion is no more than a provisional one. Where an expert witness who has prepared a report believes that it may be incomplete or inaccurate without some qualification, that qualification must be stated in the report (footnote #5).
- 2.10 The expert should make it clear when a particular question or issue falls outside the relevant field of expertise.
- 2.11 Where an expert's report refers to photographs, plans, calculations, analyses, measurements, survey reports or other extrinsic matter, these must be provided to the opposite party at the same time as the exchange of reports (footnote #6).

3. Experts' Conference

- 3.1 If experts retained by the parties meet at the direction of the Court, it would be improper for an expert to be given, or to accept, instructions not to reach agreement. If, at a meeting directed by the Court, the experts cannot reach agreement about matters of expert opinion, they should specify their reasons for being unable to do so.

footnote #1

As to the distinction between expert opinion evidence and expert assistance see *Evans Deakin Pty Ltd v Sebel Furniture Ltd* [2003] FCA 171 per Allsop J at [676].

footnote #2

See rule 35.3 Civil Procedure Rules (UK); see also Lord Woolf "Medics, Lawyers and the Courts" [1997] 16 CJQ 302 at 313.

footnote #3

See *Sampi v State of Western Australia* [2005] FCA 777 at [792]-[793], and *ACCC v Liquorland and Woolworths* [2006] FCA 826 at [836]-[842]

footnote #4

See rule 35.10 Civil Procedure Rules (UK) and Practice Direction 35 – Experts and Assessors (UK); *HG v the Queen* (1999) 197 CLR 414 per Gleeson CJ at [39]-[43]; *Ocean Marine Mutual Insurance Association (Europe) OV v Jetopay Pty Ltd* [2000] FCA 1463 (FC) at [17]-[23]

footnote #5

The "*Ikarian Reefer*" [1993] 20 FSR 563 at 565

footnote #6

The "*Ikarian Reefer*" [1993] 20 FSR 563 at 565-566. See also Ormrod "*Scientific Evidence in Court*" [1968] Crim LR 240.

NERA

Economic Consulting

NERA Economic Consulting
Darling Park Tower 3
201 Sussex Street
Sydney NSW 2000
Tel: +61 2 8864 6500
Fax: +61 2 8864 6549
www.nera.com