Determining the value of imputation credits: Joint Confidence Region and Other Multicollinearity Considerations

Dr Neil Diamond

B.Sc. (Hons), Ph.D., A.Stat.

Professor Robert Brooks

B.Ec. (Hons), Ph.D.

Report for

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MONASH University

Department of Econometrics & Business Statistics Consulting Service

Telephone: (03) 9905 2489
Fax: (03) 9905 5474

http://go.to/statconsult/

ABN: 12 377 614 012

Summary

The Victorian electricity distribution businesses are in the midst of a five-yearly price review process. As part of that review, the Australian Energy Regulator (AER) must determine an appropriate compensation for corporate income tax, which is a function of the valuation of dividend imputation credits, also referred to as gamma. Strictly speaking, gamma is defined as the product of the 'imputation credit payout ratio' (F-payout ratio) and the 'utilisation rate (θ-theta), as acknowledged by the AER (page 528 of the draft decision). However, this report concentrates only on theta, the utilisation rate. No consideration has been given to the value of the payout ratio.

The AER has taken account of a limited number of dividend drop-off studies to estimate theta, including Beggs and Skeels (2006) and a number of studies by SFG Consulting. The AER and its consultants have suggested that dividend drop-off studies are difficult because of the sensitivity of the final estimates to the inherent multicollinearity in the data, the appropriate filtering of the data, and the impact of a small number of influential observations.

In an earlier report we set out our reasons for concluding that multicollinearity does not have a serious effect on the precision of the estimates of theta in the SFG study. In this report we analyse the use of joint confidence regions and discuss the analysis of multicollinearity by the AER and others. Our conclusions remain the same: the effect of multicollinearity is only minor. The assertion made by the AER that multicollinearity is a significant concern in the SFG dividend drop-off study is quite overstated.

Declaration

We confirm that, in preparing this report, we have made all inquiries that we believe are desirable and appropriate and that no matters of significance that we regard as relevant have, to our knowledge, been witheld. We have been provided with a copy of the Federal Court's "Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia" and this report has been prepared in accordance with those Guidelines.

Contents

1 Introduction

In the Victorian draft decision, the AER has most relied on the dividend drop-off study conducted by Beggs and Skeels (2006), who fit the model:

$$P_{c,j} - P_{x,j} = \gamma_0 + \sum_{j=1}^{7} \gamma_{1,j} d_{i,j} D_i + \sum_{j=1}^{7} \gamma_{2,j} d_{i,j} F_i + \varepsilon_i, i = 1, \ldots, n \tag{1}$$

where

$$\begin{aligned}
P_{c,i} &= \text{Cum-dividend share price of } i\text{th share} \\
P_{x,i} &= \text{Ex-dividend share price for } i\text{th share,} \\
&\quad \text{(adjusted for aggregate return on the market)} \\
\gamma_{1,j} &= \text{Cash drop-off ratio for period } j \\
\gamma_{2,j} &= \text{Franking Credit drop off ratio for period } j \\
d_{i,j} &= \text{Dummy variable for } i\text{th share in period } j \\
D_i &= \text{Dividend for } i\text{th share} \\
F_i &= \text{Franking Credit for } i\text{th share} \\
\varepsilon_i &= \text{residual}
\end{aligned}$$

with an auxiliary equation involving company size, gross dividend, and the cum-dividend share price as predictor variables to account for the heteroscedasticity in the data. In this model $\gamma_{2,j}$ refers to the value of theta rather than gamma directly. Beggs and Skeels analysed data over seven tax regimes, but of major interest are the results for the last three periods. Table 1 gives dates of the seven tax regimes, adapted from Table 1 of Beggs and Skeels (2004).

Period No.	Period	Effect of tax change relative to previous regime
1	1 Apr 86–30 Jun 88	
2	1 Jul 88–30 Jun 90	Superannuation funds can use franking credits
3	1 Jul 90–30 Jun 91	Provisions to stop dividend streaming
4	1 Jul 91–30 Jun 97	Limits to life assurance funds use of franking credits
5	1 Jul 97–30 Jun 99	Provisions limiting related payments, holding period and delta hedge
6	1 Jul 99–30 Jun 00	Capital gains tax reduced
7	1 Jul 00–30 Jun 04	Tax rebate for unused franking credits

Table 1: Summary of Tax Regime Changes, adapted from Table 1 of Beggs and Skeels (2006)

Period	Parameter	Estimate	Std. Error
1 Jul 97 - 30 Jun 99	$\gamma_{1,5}$	0.795	0.099
1 Jul 99 - 30 Jun 00	$\gamma_{1,6}$	1.168	0.099
1 Jul 00 - 30 Jun 04	$\gamma_{1,7}$	0.800	0.052
1 Jul 97 - 30 Jun 99	$\gamma_{2,5}$	0.418	0.186
1 Jul 99 - 30 Jun 00	$\gamma_{2,6}$	0.128	0.204
1 Jul 00 - 30 Jun 04	$\gamma_{2,7}$	0.572	0.121

Table 2: Beggs and Skeels results

Table 2 gives the results of Beggs and Skeels for the last three periods. The AER has used the $\hat{\gamma}_{2,7}$ figure of 0.572 in its determination of the appropriate value of theta and therefore gamma.

In an earlier report (Diamond and Brooks, 2010a) we focused on a regression analysis, which we called Fit1, that was based on a database constructed by SFG Consulting (2010b). Table 3 gives a summary of Fit1, using the R Statistical Computing Environment (R Core Team, 2010). The results are identical to the results of SFG Consulting (2010b, page 5, top panel, middle column).

Period	Parameter	Estimate	Std. Error
	γ_0	-0.0078	0.0023
1 Jul 97 - 30 Jun 99	$\gamma_{1,5}$	0.9419	0.0716
1 Jul 99 - 30 Jun 00	$\gamma_{1,6}$	0.8274	0.1096
1 Jul 00 - 30 Sep 06	$\gamma_{1,7}$	0.9856	0.0306
1 Jul 97 - 30 Jun 99	$\gamma_{2,5}$	0.2144	0.1654
1 Jul 99 - 30 Jun 00	$\gamma_{2,6}$	0.3601	0.2420
1 Jul 00 - 30 Sep 06	$\gamma_{2,7}$	0.2274	0.0822

Table 3: Fit1, produced by SFG

2 Multicollinearity

Dividend drop off studies aim to separate the differential value of cash dividends and franking credits, and can suffer from multicollinearity. This issue appears to be one of the strongest criticisms by the AER of work commissioned by the Victorian businesses and their South Australian counterpart.

Beggs and Skeels (2006) considered the issue, but concluded (p.245):

> ... and so we do not believe that multicollinearity is a major concern for this dataset.

However, the AER (2009) stated

> SFGs dividend drop off study is prone to the common problem of multicollinearity

in the regression model.

SFG conducted studies on the issue and have advocated the use of joint confidence regions. They support the Beggs and Skeels (2006) position. However, McKenzie and Partington (2010) say

> We believe that multicollinearity is a serious problem for dividend drop off studies and the results of SFG and Beggs and Skeels (2006) cannot be reliably interpreted in the presence of multicollinearity. Further, until serious consideration is given to this issue, reliable decomposition of the partial effect of cash dividends and franking credits will remain elusive

In a previous report (Diamond and Brooks, 2010a) we examined the variance inflation factors and an eigenvalue decomposition of the variance-covariance matrix and concluded that multicollinearity was not a serious matter, contrary to the assertions made by the AER and other parties. If multicollinearity had been completely absent (a phenomenon rarely observed in practice), then the standard errors would have been reduced by a comparatively small margin.

2.1 Analysis by SFG

SFG (January, 2010) studied the effects of multicollinearity by calculating a joint confidence region for the cash dividend and imputation credit regression parameters. This section will examine that analysis.

Greene (5th Ed, 2004, pp 276-277) shows that

> ... the joint confidence region is the set of values $\beta = (\beta_1, \beta_2)'$ for which
>
> $$\frac{1}{2}(b-\beta)'\Omega^{-1}(b-\beta)$$
>
> is less than the critical value of $F[2, n-K]$, where b represents the parameter estimates, Ω is the estimated covariance matrix of the relevant parameters, n is the number of observations in the sample, and K is the number of parameters being estimated.

Beggs and Skeels (2006) assumed that the estimation method which they devised would give rise to normally distributed residual terms with homogeneous variance. Rather than constructing a

joint confidence region using the variance-covariance matrix and standard errors associated with the reported results for Fit1, SFG constructed a joint confidence region using a heteroscedastic adjusted covariance matrix (based on White's adjustment for heteroscedasticity). The resulting confidence region, shown on page 7 of SFG (2010a), is quite broad, and is capable of incorporating both the Beggs and Skeels (2006) parameter estimates, and the parameter estimates obtained by SFG.

However, in the absence of normality, the confidence region constructed on this basis rests on asymptotic arguments, which may not hold. In addition, least squares regression is optimal if the error terms are normally distributed. However, there is evidence that the errors for Fit1 have long tails[1], and least squares regression is generally sub-optimal in such circumstances (see, for example, Fox, 2008, page 530), and hence the confidence region may be larger than it should be if a more sophisticated method for estimation were used.

Rather than simply assume normality of the regression residuals from the weighted least squares estimation, we applied a robust and resistant regression method, and checked the accuracy of the confidence region using bootstrap methods. The robust method which we applied was MM regression (Yohai, Stahel, and Zamar, 1991; see also Venables and Ripley, 2004, page 161). MM regression[2] is a bounded influence method, and is tuned to give 95% efficiency for normally distributed data, but is resistant to unusual observations. By contrast, the least squares approach has 100% efficiency at the Normal but performs less satisfactorily when this assumption does not hold, as may be the case here.

The method of constructing the joint confidence region that we use is based on bootstrap calculations (see, for example, Fox, 2008, pp 587-606) as follows:

1. Apply MM regression instead of OLS to the SFG data set.

2. Use the logarithm of the squared residuals from the first step as the dependent variable in the auxiliary regression, again fitted using MM regression. The inverse of the exponential of the fitted values from this fit are used as weights.

3. Construct 1,000 replicated data sets, using case based resampling, that is sampling from

[1]The evidence that the errors for Fit1 have long tails is provided by the discussion of the exclusion of outliers in Skeels (2009).

[2]The use of robust regression methods, such as MM regression, has also been suggested by McKenzie and Partington (2010, page 12).

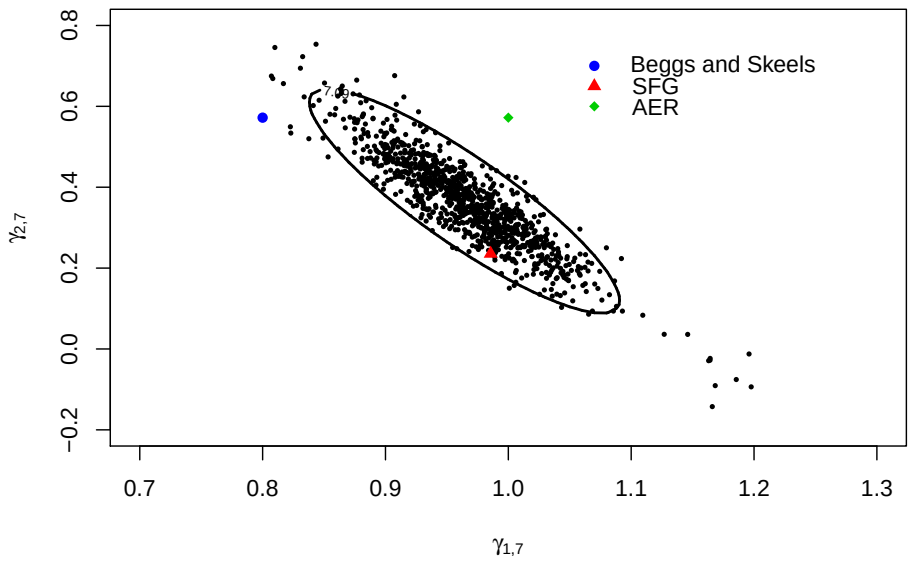

Figure 1: 95% Joint Confidence Regions based on Bootstrap resampling.

the original data with replacement.[3]

4. For each replicated data set, the weights from step 2 are applied to the observations and the regression model is fitted to the data.

With the bootstrap, the confidence region for the parameters can be determined from the replicated results without having to rely on asymptotic arguments or having to make distributional assumptions. The results are given in Figure 1.

To determine the confidence region, a robust measure of location, c, and covariance, V, was determined using the `cov.rob` procedure in the MASS package in R. For each of the 1,000 bootstrap samples with estimates of the parameters b, the quadratic form

$$q = (b - c)^T V^{-1} (b - c)$$

[3]There are two common ways for bootstrapping regression models. One way, called *model based resampling* involves sampling the original residuals with replacement and creating replicated datasets where the dependent variable is the sum of the fitted values plus resampled residuals. For each replicated dataset, the original analysis is applied. The alternative method, which is considered safer (see, for example, Fox, p.598) when the residuals have nonconstant variance or when there are high leverage outliers, is *case based resampling*, where the cases (including both the dependent and independent variables) are sampled with replacement to form the replicated data sets. We have used the second method, stratifying by period-that is each replicated data set has the same number of observations in each period as in the SFG data set.

was determined and the 95% confidence region consists of the ellipse containing the points where the corresponding quadratic form was less than the 95th percentile of the q's. At the 5% level of significance, the joint confidence region for a set of paired parameters (for the value of cash dividends and the value of imputation credits) is the set of values for which the hypothesis that the set of true parameter estimates simultaneously equals these values would not be rejected. The 95th percentile defines the boundary of the ellipse. At the 5% level of significance, all combinations of the parameters that would not be rejected lie within the ellipse.

As noted above, the quadratic form was determined for 1,000 bootstrap samples. The output was 1,000 values or paired parameter estimates. The 95% confidence region was established by taking values up to the 95th percentile.

Note that the SFG estimate of the paired parameters is included in the confidence region. The calculated quadratic form for the SFG estimate is at the 81.1th percentile, that is the SFG estimate would fall on the boundary of an 81.1% confidence region which would contain 81.1% of the bootstrap paired parameter estimates. Also note that the Beggs-Skeels estimate is not inside the 95% confidence region. In fact the calculated quadratic form for this point is at the 99.4th percentile. Even more extreme is the AER's preferred estimate which involves fixing the value of cash dividends at 1.0 and assuming that the estimate of theta is 0.57.

Based on the bootstrap confidence region it can be concluded that the SFG estimates of theta and of the value of cash dividends fit the data better than the Beggs-Skeels estimate.

2.1.1 Analysis of differences between parameters

The confidence region shows that the parameter estimates for each period are negatively correlated. It can be shown as well that between periods the parameters are effectively independent,[4] as can be seen from examining the correlation matrix of the estimated parameters which is given

[4]The estimated parameters for the value of cash dividends and the value of franking credits are not completely independent from one discrete interval to the next because, consistent with the approach taken by Beggs and Skeels (2006), the auxiliary equation is fitted across the entire sample of data used.

by

$$R = \begin{pmatrix} 1 & -0.248 & -0.200 & -0.402 & -0.008 & 0.029 & -0.049 \\ -0.248 & 1 & 0.050 & 0.100 & -0.790 & -0.007 & 0.012 \\ -0.200 & 0.050 & 1 & 0.080 & 0.002 & -0.826 & 0.010 \\ -0.402 & 0.100 & 0.080 & 1 & 0.003 & -0.011 & -0.729 \\ -0.008 & -0.790 & 0.002 & 0.003 & 1 & 0.000 & 0.000 \\ 0.029 & -0.007 & -0.826 & -0.011 & 0.000 & 1 & -0.001 \\ -0.049 & 0.012 & 0.010 & -0.729 & 0.000 & -0.001 & 1 \end{pmatrix}.$$

Note that the maximum absolute value of correlation between the γ_1's is 0.1, and the maximum absolute value of the correlation between the γ_2's is 0.001, both very small. The first column and first row of the matrix show correlations involving the intercept term.

The correlation matrix can be used to provide standard errors of changes in the parameters from one period to the next. These are given in Table 4.[5] The standard errors are relatively large– it is harder to measure changes in the parameters than the individual parameters themselves. However, these large standard errors are not due to any multicollinearity in the data. To demonstrate this, we have determined what the standard errors would be without the multicollinearity by dividing the individual standard errors by the square root of the Variance Inflation Factors (VIFs) given in Table 4 of Diamond and Brooks (2010a), and combining them on the assumption of approximate independence, as shown in the correlation matrix.

The effective square root of the VIFs are given by the ratio of the two standard errors. These are all between 1.7 and 1.8, indicating that the effective VIFs are less than 4, much less than 10, which is the usual criterion for concern.

The contribution of multi-collinearity to the standard error of the difference is low by comparison with what might be expected if multi-collinearity were more prevalent and pervasive in terms of the variables used in the regression. For gamma, the standard error of the difference is 0.256, between periods 6 and 7, and would be 0.145 if there were no multi-collinearity at all. However, a complete absence of multi-collinearity is a theoretical ideal which cannot be reached.[6] The

[5] The bootstrap standard errors for the cash dividend parameter changes are slightly larger than those in Table 4: 0.164 vs 0.128; 0.131 vs 0.111. For changes in the imputation credits parameter the differences are very minor: 0.307 vs 0.293, and 0.251 vs 0.256.

[6] Observations on economic variables are not generated under controlled conditions and, as a result, almost any correlation measure between two or more columns of the regressor matrix X will produce a result different to zero. The name given to this phenomenon is multicollinearity. It is important to realise that multicollineariy is generally a property of the data. There is no violation of the assumptions of the classical model except in the

Parameter	Estimate	Std. Error	Std.Error Without Multicollinearity	"$\sqrt{VIF}$"
$\gamma_{1,6} - \gamma_{1,5}$	-0.114	0.128	0.074	1.737
$\gamma_{1,7} - \gamma_{1,6}$	0.158	0.111	0.064	1.753
$\gamma_{2,6} - \gamma_{2,5}$	0.146	0.293	0.167	1.756
$\gamma_{2,7} - \gamma_{2,6}$	-0.133	0.256	0.145	1.762

Table 4: Estimates and standard errors of parameters. The standard errors are shown for changes in the parameters from one period to the next, based on the variance-covariance matrix of the estimated parameters for Fit1. For example, the 0.256 for $\gamma_{2,7} - \gamma_{2,6}$ is worked out as the square root of $((0.242)^2 + (0.082)^2 - 2(-0.001)(0.242)(0.082))$ where the constituent standard errors are drawn from Diamond and Brooks (2010a) and -0.001 is the correlation between the parameter estimates. An estimate of what the standard error would be without any multicollinearity is given in column 4, and the effective square root of the Variance Inflation Factor is given in column 5. The standard errors shown in column 3 do not assume independence of the parameter estimates from one period to the next. However, the standard errors without multicollinearity shown in column 4 are calculated by assuming independence.

multi-collinearity does not help, but it is not the main issue. The relatively small number of observations in period 6 contributes to higher standard errors for both individual parameter estimates and estimates of changes in the parameters from one period to the next.

2.2 Analysis by McKenzie and Partington

McKenzie and Partington (2010, p.45) stated that the joint confidence region showed "that SFG's results were entirely consistent with those derived from other attempts at estimating gamma." As indicated above, the Beggs and Skeels (2006) results are not consistent with the bootstrap confidence region when it is measured at the 95% level of significance. On the other hand, the SFG results are consistent with the bootstrap confidence region.

McKenzie and Partington (2010, p.46) also state:

> When faced with the issue of multicollinearity, the researcher may attempt to obtain more and better quality sample data. This is unlikely to prove helpful in the current

extreme case in which one of the regressors, X_j, is an exact linear function of other regressors. If this happens, the matrix X^TX is singular and the regression calculation fails. So at one extreme, the regressors are orthogonal and X^TX is diagonal. At the other extreme, X^TX is singular. In between the extremes, we have multicollinearity of some degree. For a further explanation, see Stewart and Gill (1998).

Since there is almost always some intercorrelation between regressor variables, multicollinearity is almost always present to some extent, but multiple regression recognises this fact and produces estimates accordingly. There are problems that arise when some of the measured correlations become very high, but that is definitely not the situation with the SFG data.

> context however, since a longer time series of data may suffer from the same collinear relationships and provide little new information.

This advice is erroneous. As discussed in Diamond and Brooks(2010a, p.6) and following Fox (2008, p.308)

> The sampling variance of a least squares slope coefficient B_j is
>
> $$V(B_j) = \frac{1}{1 - R_j^2} \times \frac{\sigma_\varepsilon^2}{(n-1)S_j^2}$$
>
> where R_j^2 is the squared multiple correlation for the regression of X_j on the other Xs, and $S_j^2 = \sum(X_{ij} - \overline{X})^2/(n-1)$ is the variance of X_j. The term $1/(1 - R_j^2)$ is called the variance inflation factor.

Quite clearly, irrespective of any multicollinearity in the data, more data (i.e. a larger n) and better quality sample data (i.e. a smaller σ^2) will improve the estimates of the regression coefficients.

McKenzie and Partington's (2010, p.47) discussion of the impact of multicollinearity is predicated on the confidence region calculated by SFG. However, using the robust and bootstrap methods, the confidence region is much smaller and hence their conclusions do not apply.

2.3 Analysis by Handley

Handley (2010, p.29-32) also makes comments on the imprecision of dividend drop-off studies based on SFG's expansive confidence region. Again, using the more precisely defined bootstrap confidence region, many of Handley's conclusions are not warranted.

2.4 Considerations by AER

In their Victorian Draft Distribution Determination-Draft Decision the AER (2010, p.542) state, based on the analysis of McKenzie and Partington

> The presence of multicollinearity in the regression model indicates that the separate effects of cash dividends and imputation credits on share drop-off cannot accurately be determined.

Again, this is an erroneous conclusion. For Fit1, the difference between the estimated effects is 0.758, over 7 times the standard error of the difference, based on the variance-covariance matrix of the estimated parameters. The 0.758 is worked out as $(0.9856 - 0.2274)$, drawing upon the values in Table 3, in respect of period 7. The standard error for the difference in the parameters, again based on the variance-covariance matrix of the estimated parameters, is 0.107. In addition, a 95% bootstrap confidence interval for the difference between the parameter estimates (of cash dividends and franking credits in period 7) has limits of 0.27 and 0.91, clearly indicating that the two parameters can be separately estimated.

Based on McKenzie and Partington's (2010, p.44) observation that theoretically there is a perfect collinearity between cash credits and imputation credits, the AER notes that multicollinearity is a significant concern for dividend drop-off studies. They state (2010, p.542, footnote 70), incorrectly, that "Tax rate and regime changes over time are the only reason that cash dividends and imputation credits are not perfectly correlated in SFG's data set". The existence of the 25% of non-franked dividends is the major reason that separate effects can be estimated.

We agree with Skeels (2009, p.19) who stated that there was no evidence that multicollinearity is a concern for either of the Beggs and Skeels (2006) or the 2009 SFG dividend drop-off studies. If multicollinearity was a concern, then large standard errors would be observed. It should be noted that the estimate of $\gamma_{2,7}$ is significant at the 1% level.

Based on McKenzie and Partington's (2010, p.44) analysis, who observed the correlation coefficient between cash dividends and imputation credits being 0.70 after the 0.03 per cent filter is applied; and 0.9899 for the unfiltered data set where dividends are fully franked, the AER considered that the SFG data set is prone to multicollinearity. Again the existence of the 25% of non-franked dividends is most important here.

The AER also note that the non-significance of theta for the 1 July 2000 to 10 May 2004 period, and an estimate of the value of cash dividends greater than 1 indicates the existence of multicollinearity. These results may also be due to the reduced sample size and variability in the data. In fact, with the extended data set used by SFG (2010b), the theta estimate is statistically significant and the estimate of the value of cash dividends is less than 1.

McKenzie and Partington (2010, p.48) prepared a figure similar to Figure 2 where they plotted the change in the raw stock price on the ex-dividend day against the cash dividend and

the imputation credit. They claimed the graph showed that the cash dividend coefficients are estimated to be significant whist franking credits are not significant. The AER have concluded that this demonstrates the issue of multicollinearity. However the Figure seems quite consistent with the SFG estimates (see the superimposed lines on the graph). Additionally, it is puzzling that McKenzie and Partington conclude the non-significance of the franking credit coefficient. A multiple linear regression gives a highly significant franking credit coefficient, as does a robust multiple linear regression. Correcting for heteroscedasticity using White's heteroscedastic-consistent standard errors the franking credit coefficient remains statistically significant at the 5% level.

For these reasons we do not agree with McKenzie and Partington's (2010) analysis, nor do we agree with AER's interpretation of it when they say "McKenzie and Partington's analysis demonstrates that SFG's regression results are likely to be affected by multicollinearity and as a result the values of imputation credits are likely understated". Any multicollinearity, if it exists, increases the variability of the estimate but does not bias the estimate.

The AER also considered the joint confidence region given by SFG and the subsequent advice by McKenzie and Partington and also by Handley. Many of these considerations no longer apply with the more precisely defined confidence region.

2.5 Conclusions

Our conclusions remain the same as those in our earlier report: Multicollinearity does not seem to be a significant problem in the dataset used by SFG. The cash dividend and imputation credit parameters, whilst negatively correlated, are sufficiently well estimated for the most recent period.

The parameter estimates provided by SFG are statistically different from those provided by Beggs and Skeels.

A 95% joint confidence region constructed using the methods described in section 2.1 of this report produces an ellipse which is less expansive than that illustrated in SFG (2010a). This ellipse incorporates the paired parameter estimates derived by SFG (0.9856 for the cash dividend, and 0.2274 for the franking credit), but does not incorporate the parameter estimates obtained by Beggs and Skeels.

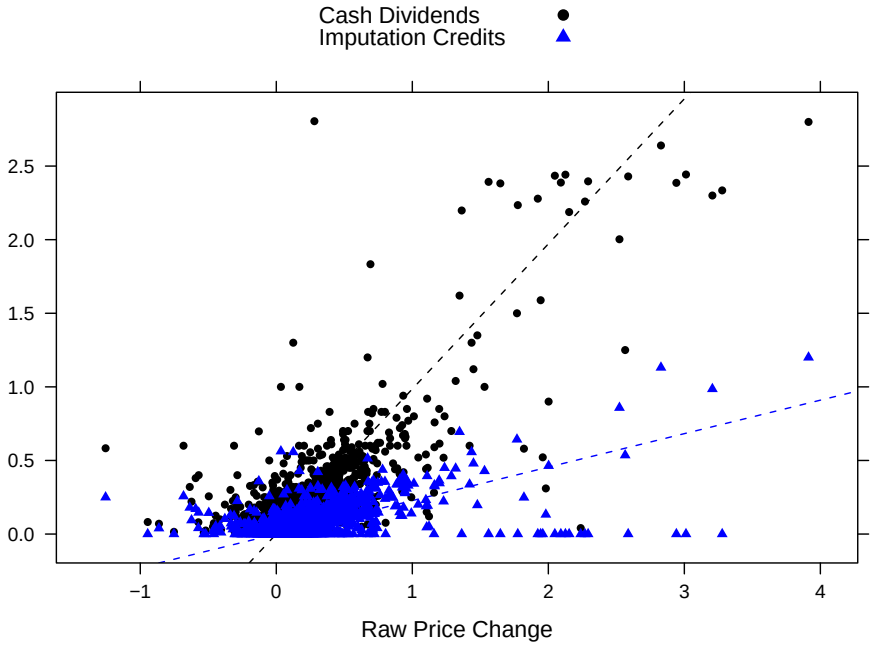

Figure 2: Raw Stock Prices against cash dividends and franking credits, based on the graph produced by McKenzie and Partington. The dotted lines are the regression slopes for Fit1 (Period 7).

Hence, the bootstrap confidence region developed for this report shows that the SFG estimates of theta and of the value of cash dividends fit the data better than the Beggs and Skeels parameter estimates.

The confidence region constructed by SFG (and illustrated in SFG, 2010a) is not wrong, but is highly conservative in the current circumstances. If the confidence region is established using the more detailed methods shown in this report, then the conclusions by the AER's consultants, McKenzie and Partington (2010), fall away. Mckenzie and Partington (2010, page 45) stated that "SFG's results were entirely consistent with those derived from other attempts at estimating gamma". This statement is simply not correct in view of the revised confidence region.

In addition, the following comment by McKenzie and Partington is puzzling and seems somewhat misplaced.

> "Given the inability of the estimation technique to reliably decompose the partial effect of cash dividends and franking credits due to multicollinearity, it is not surprising that the cash dividend dominates in the estimation process" (McKenzie and Partington, page 48).

As noted in this report, a multiple linear regression gives a highly significant franking credit coefficient, as does a robust multiple linear regression. Correcting for heteroscedasticity using White's heteroscedastic consistent standard errors, the franking credit coefficient remains statistically significant at the 5% level.

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Neil Diamond CV

August 2010

Full Name:	Neil Thomas Diamond
Academic Qualifications:	B.Sc (Hons) (Monash), Ph.D. (Melbourne), A.Stat

Career History

1977-78	Statistician, ICI Explosives Factory, Deer Park
1979-86	Research Officer, Research Scientist, Senior Research Scientist And Statistics and Computing Team Leader, ICI Central Research Laboratories, Ascot Vale
1987-1989	Lecturer, Department of Mathematics, Computing and Operations Research, Footscray Institute of Technology
(1989)	Visiting Scientist, Center for Quality and Productivity Improvement, University of Wisconsin-Madison, USA.
1990-2003	Senior Lecturer, Department of Computer and Mathematical Sciences, Victoria University of Technology
(1995)	Visiting Fellow, Center for Quality and Productivity Improvement, University of Wisconsin-Madison, USA.
2003-2004	Senior Statistician, Insureware
2004-2006	Senior Lecturer and Deputy Director of Consulting, Department of Econometrics and Business Statistics, Monash University.
2007-	Senior Lecturer and Director of Consulting, Department of Econometrics and Business Statistics, Monash University.

Teaching Experience

Monash University

- Business Statistics (First Year), Marketing Research Analysis (Second Year), Survey Data Analysis (Third Year-Clayton and Caulfield).
- Expert Stats Seminars on Software Packages for Statistics, Questionnaire Design, Analysis of Survey Data, and Multivariate Statistics.
- Introduction to Statistics for Pharmacy-five session course:
  - Data handling, exploration, and graphical summaries
  - An overview of basic statistical methods

- Regression Analysis and extensions
- Designing experiments and power analysis
- An overview of more advanced statistical methods

Victoria University of Technology

- Applied Statistics (First Year), Linear Statistical Models, Sampling and Data Analysis (Second Year), Experimental Design (Third Year).
- Statistics for Engineers, Statistics for Nurses, Statistics for Occupational Health.
- Forecasting (Graduate Diploma in Business Science)

Sessional Teaching

- Monash University (1996-2003) Design of Experiments for Masters Students of the Australian Pulp and Paper Institute.
- RMIT (1991, 1996-2002) Design of Experiments for Masters in Quality Management.
- AGSM (1993-1997): Total Quality Management for Graduate Management Qualification.
- Various other: The University of Melbourne, Enterprise Australia, Swinburne Institute of Technology.

Supervision

Principal Supervisor

Gregory Simmons (1994-1997). M.Sc. completed. "Properties of some minimum run resolution IV designs."

Tony Sahama (1995-2003). Ph.D. completed. "Some practical issues in the design and analysis of computer experiments."

Ewa Sztendur (1999-2005). Ph.D. completed. "Precision of the path of steepest ascent in response surface methodology." [As a result of this thesis, Ewa was awarded the 2006 Victoria University Vice-Chancellor's Peak Award for Research and Research Training-Research Degree Graduate.]

Co-supervisor

Keith Hart (1996-1997). M.Sc. completed. "Mean reversion in asset prices and asset allocations in funds management."

Jyoti Behera (1999-2000). M.Eng. completed. "Simulation of container terminals."

Ray Summit (2001-2004). Ph.D. completed. "Analysis of warranty data for automobile data."

Rob Moore (2001-2007). Ph.D. completed. "Computer recognition of musical instruments.

M.Sc. Minor Theses

Milena Shtifelman (1999). Completed. (Monash University Accident Research Centre). "Modelling interactions of factors influencing road trauma trends in Victoria."

Rohan Weliwita (2002). Completed. "Modelling road accident trauma data."

Theses Examination

One M.Sc. major thesis (University of Melbourne) and one M.Sc minor thesis (Victoria University).

Industry Projects

Over 30 projects for the following companies and organisations:

Gas and Fuel Corporation	Ford Australia
Mobil Australia	Fibremakers
ICI Australia	Western General Hospital
Data Sciences	Keilor City Council
AMCOR	Composite Buyers
Davids	Email Westinghouse
Craft Coverings	Australian Wheat Board
CSL	Holding Rubber
Viplas Olympic	Melbourne Water
Federal Airports Corporation	

Research and Consulting Experience

- Ten years with ICI Australia as an industrial statistician initially with the Explosives group and eventually with the research group.
- A Ph.D. from the University of Melbourne entitled "Two-factor interactions in non-regular foldover designs."
- Two six month periods at the Center for Quality and Productivity Improvement at the University of Wisconsin-Madison.
- Extensive consulting and training on behalf of the Centre for Applied Computing and Decision Analysis based at VUT for the following companies:

Data Sciences	Initiating Explosives Systems
Analytical Science Consultants	Saftec
Glaxo Australia	Datacraft Australia
Enterprise Australia	ICI Australia
The LEK partnership	Kaolin Australia
BP Australia	AMCOR
Melbourne Water	Kinhill Group
Australian Pulp and Paper Institute	

- Operated the Statistical Consulting Service at Victoria University of Technology from 1992-2002.
- From 2002-2004 worked as a Senior Statistician with Insureware on the analysis of long-tailed liability data.
- From December 2004 to December 2006 Deputy Director of Consulting of Monash University Statistical Consulting Service based in the Department of Econometrics and Business Statistics.
- From January 2007 Director of Consulting of Monash University Statistical Consulting Service based in the Department of Econometrics and Business Statistics.
- Extensive consulting and training on behalf of the Monash University Statistical Consulting Service for the following companies and organisations:

Australian Tax Office	Department of Human Services
J D McDonald	IMI Research
Port of Melbourne Corporation	Incitec Pivot
Agricola, Wunderlich & Associates	Parks Victoria
Australian College of Consultant Physicians	ANZ
Department of Justice	CRF(Colac Otway)

Journal Articles

1. Diamond, N.T., (1991). "Two visits to Wisconsin," *Quality Australia*, **7**, 30-31.

2 Diamond, N.T., (1991). "The use of a class of foldover designs as search designs," *Austral. J. Statist*, **33**, 159-166.

3 Diamond, N.T., (1995). "Some properties of a foldover design," *Austral. J. Statist*, **37**, 345-352.

4 Watson, D.E.R., Hallett, R.F., and Diamond, N.T., (1995). "Promoting a collegial approach in a multidisciplinary environment for a total quality improvement process in higher education, " *Assessment & Evaluation in Higher Education*, **20**, 77–88.

5 Van Matre, J. and Diamond, N.T., (1996). "Team work and design of experiments," Quality Engineering, 9, 343–348.

6 Diamond, N.T., (1999). "Overlap probabilities and delay detonators," *Teaching Statistics*, **21**, 52–53. Also published in "Getting the Best from Teaching Statistics", one of the best 50 articles from volumes 15 to 21 of *Teaching Statistics*.

7 Cerone, P. and Diamond, N.T., (2000). "On summing permutations and some statistical properties," *The International Journal of Mathematical Education in Science and Technology*, **32**, 477-485.

8 Behera, J.M., Diamond, N.T., Bhuta, C.J. and Thorpe, G.R.,(2000). "The impact of job assignment rules for straddle carriers on the throughput of container terminal detectors," *Journal of Advanced Transportation*, **34**, 415-454.

9 Sahama, T. and Diamond, N.T., (2001). "Sample size considerations and augmentation of computer experiments," *The Journal of Statistical Computation and Simulation*, **68**, 307-319.

10 Paul, W. and Diamond, N.T., (2001). "Designing a monitoring program for environmental regulation: Part 1-The operating characteristic curve," *Water*: Journal of Australian Water Association, October 2001, 50-54.

11 Sztendur, E.M. and Diamond, N.T., (2002). "Extension to confidence region calculations for the path of steepest ascent," *Journal of Quality Technology*, **34**, 288-295.

12 Paul, W. and Diamond, N.T., (2002). "Designing a monitoring program for environmental regulation: Part 2-Melbourne Water case study," *Water*: Journal of Australian Water Association, February 2002, 33-36.

13 Steart, D.C., Greenwood, D.R., Boon, P.I. and Diamond, N.T., (2002) "Transport of leaf litter in upland streams of Eucalyptus and Nothofagus forests in South Eastern Australia," *Archiv Für Hydrobiologie,* **156***, 43-61.*

14 Peachey, T. C., Diamond, N. T., Abramson, D. A., Sudholt, W., Michailova, A., and Amirriazi, S. (2008). "Fractional factorial design for parameter sweep experiments using Nimrod/E,"*Sci. Program.*, **16**(2-3), 217–230.

15 Sahama, T.R. and Diamond, N.T. (2009) "Computer Experiment-A case study for modelling and simulation of Manufacturing Systems," *Australian Journal of Mechanical Engineering*, **7**(1), 1–8.

Diamond, N.T. and Sztendur, E.M. (2010) "Using Fractional Factorial Designs for Variable Importance in Random Forest Models", submitted to *Statistical Analysis and Data Mining.*

Refereed Conference Papers

1. Behera, J., Diamond, N.T., Bhuta, C. and Thorpe, G., (1999). "Simulation: a decision support tool for improving the efficiency of the operation of road vehicles in container terminals," 9th ASIM Dedicated Conference, Berlin, February 2000, 75-86.

2. Jutrisa, I., Diamond, N.T. and Cerone. P., (1999). "Frame size effects on throughput and return traffic in reliable satellite broadcast transmission, " 16th International Teletraffic Congress, Edinburgh, Scotland.

3. Sztendur, E.M. and Diamond, N.T.* (2001). "Inequalities for the precision of the path of steepest ascent in response surface methodology," in Cho, Y.J, Kim, J.K., and Dragomir, S.S. (eds.) *Inequality Theory and Applications,* **1***, The Proceedings of the Sixth International Conference 2000 on Nonlinear Functional Analysis and Applications*, Chinju and Masan, South Korea, 295-301.

4. Diamond, N.T. and Sztendur, E.M. (2002). "The use of consulting problems in introductory statistics classes", *Proceedings of the 6th International Conference on the Teaching of Statistics*.

5. Summitt, R.A., Cerone. P., and Diamond, N.T. (2002). "Simulation Reliability Estimation from Early Failure Data, *Proceedings of the Fourth International Conference on Modelling and Simulation*, 368-390.

6. Summitt, R.A., Cerone. P., and Diamond, N.T. (2002). "Simulation Reliability Estimation from Early Failure Data II, *Proceedings of the Fourth International Conference on Modelling and Simulation*, 391-396.

7. Sahama, T. And Diamond, N.T. (2008). "Computer Experiment-A case study for modelling and simulation of Manufacturing Systems," 9th Global Conference on Manufacturing and Management.

Reports

A number of confidential reports for ICI Australia from 1977-1987.

Victoria University

VU1. Diamond, N.T (1990). "Professional Experience Program at the Center for Quality and Productivity Improvement," Footscray Institute of Technology.

VU2. Bisgaard, S. and Diamond, N.T (1991). "A discussion of Taguchi's methods of confirmatory trials," Report No. 60. Center for Quality and Productivity Improvement, University of Wisconsin-Madison.

VU3. Diamond, N.T (1996). "Outside Studies Program at the Center for Quality and Productivity Improvement," Victoria University of Technology.

VU4. Diamond, N.T (1996). "Statistical Analysis of EPA compliance of the western treatment plant," prepared for Melbourne Water on behalf of Kinhill Engineers.

VU5. Diamond, N.T (1996). "Statistical Analysis of EPA compliance of the western treatment plant," prepared for Melbourne Water on behalf of Kinhill Engineers.

VU6. Diamond, N.T (1998). "Statistical Analysis of BOD and SS compliance rates and license limits at ETP and WTP," prepared for Melbourne Water.

VU7. Diamond, N.T (1998). "Fate of pollutants at WTP-method for determining safety margins," prepared for Egis consulting group.

VU8. Bromley, M. and Diamond, N.T (2002). "The manufacture of Laboratory coreboard using various chip furnishes," prepared for Orica adhesives and resins.

Monash University

M1. Hyndman, R.J, Diamond, N.T. and de Silva, A. (2004). "A review of the methodology for identifying potential risky agents," prepared for the Australian Tax Office.

M2. Diamond, N.T. and Hyndman, R.J. (2005). "Sample Size for Maternal and Child Heath Service Evaluation," prepared for the Department of Human Services.

M3. Diamond, N.T. (2005). "Analysis of Customer Satisfaction Survey 2005," prepared for JD Macdonald.

M4. Diamond, N.T. (2005). "Analysis of 2005 Orientation Survey," prepared for Monash Orientation.

M5. Diamond, N.T. (2005). "Analysis of Before and After and Sequential Monadic Concept Consumer Surveys," prepared for IMI-Research.

M6. Diamond, N.T. and Hyndman, R.J. (2005). "The Monash Experience Questionnaire 2003: First Year Students," prepared for CHEQ, Monash University.

M7. Diamond, N.T. and Hyndman, R.J. (2005). "The Monash Experience Questionnaire 2003: The Best and Worst, " prepared for CHEQ, Monash University.

M8. Diamond, N.T. and Hyndman, R.J. (2005). "The Monash Experience Questionnaire 2003: The Best and Worst for First Year Students," prepared for CHEQ, Monash University.

M9. Diamond, N.T. (2005). "Technical Document for DUKC Uncertainty Study," prepared for Port of Melbourne Corporation.

M10. Diamond, N.T. (2005). "DUKC Uncertainty Study-Summary of Results," prepared for Port of Melbourne Corporation.

M11. Diamond, N.T. (2005). "Number of Ship trials for DUKC Uncertainty Study," prepared for Port of Melbourne Corporation.

M12. Diamond, N.T. (2005). "Threshold Criteria for Touch Bottom Probabilities," prepared for Port of Melbourne Corporation.

M13. Diamond, N.T. and Hyndman, R.J. (2006). "The Monash Experience Questionnaire 2005: The Best and Worst," prepared for CHEQ, Monash University.

M14. Diamond, N.T. and Hyndman, R.J. (2006). "The Monash Experience Questionnaire 2005: The Best and Worst for First Year Students," prepared for CHEQ, Monash University.

M15. Diamond, N.T. and Hyndman, R.J. (2006). "The Monash Experience Questionnaire 2005: A Statistical Analysis," prepared for CHEQ, Monash University.

M16. Diamond, N.T. and Hyndman, R.J. (2006). "The Monash Experience Questionnaire 2005: 2005 vs. Pre-2005 Students," prepared for CHEQ, Monash University.

M17. Diamond, N.T. (2006). "Agreement of 110/116 and 111/117 items by Consultant Physicians," prepared for the Australian College of Consultant Physicians.

M18. Diamond, N.T. (2006). "Analysis of Statistical Issues regarding Cornish v Municipal Electoral Tribunal, " prepared for Agricola, Wunderlich & Associates.

M19. Diamond, N.T. (2006). "Analysis of Parks Victoria Staff Allocation," prepared for Parks Victoria.

M20. Diamond, N.T. and Hyndman, R.J. (2006). "Summary of Results of IPL Sales Forecasting Improvement Project," prepared for Incitec Pivot.

M21. Sztendur, E.M. and Diamond, N.T. (2007) "A model for student retention at Monash University", prepared for University retention committee.

M22. Sztendur, E.M. and Diamond, N.T. (2007) "An extension to a model for student retention at Monash University", prepared for University review of coursework committee.

M23. Sztendur, E.M. and Diamond, N.T. (2007) "A model for student academic performance at Monash University", prepared for University review of coursework committee.

M24. Diamond, N.T. (2007). "Analysis of IB student 1st year results at Monash University 2003-2005", prepared for VTAC.

M25. Diamond, N.T. (2008). "Effect of smoking bans on numbers of clients utilising problem gambling counselling and problem gambling financial counselling", prepared for Department of Justice

M26. Diamond, N.T. (2008). "Development of Indices Based Approach for Forecasting Gambling Expenditure at a Local Government Area Level", prepared for Department of Justice

M27. Diamond, N.T. (2008). "Orientation 2007- Analysis of Quantitative results", prepared for University Orientation committee.

M28. Diamond, N.T. (2008). "Orientation 2007- Analysis of Qualitative results, prepared for University Orientation committee.

M29. Diamond, N.T. (2008). "Analysis of Clients presenting to Problem Gambling Counselling Services-2002/03 to 2005/06", prepared for the Department of Justice.

M30. Diamond, N.T. (2008). "Analysis of Clients presenting to Problem Gambling Financial Counselling Services-2001/02 to 2005/06", prepared for the Department of Justice.

M31. Diamond, N.T. (2008). "Analysis of Clients presenting to Problem Gambling Counselling and Problem Gambling Financial Counselling Services-2006/07", prepared for the Department of Justice.

M32. Diamond, N.T. (2008). "The effect of changes to Electronic Gaming Machine numbers on gambling expenditure", prepared for the Department of Justice.

M33. Diamond, N.T. (2009). "Adjustment of Mark Distributions", prepared for the Faculty of Law.

M34. Diamond, N.T. (2009). "Summary of Results for Dyno Nobel Sales Forecasting Improvement Project," prepared for Incitec Pivot.

R Packages

R1. Diamond, N.T. (2010), VizCompX

Professional Service

- President, Victorian Branch, Statistical Society of Australia, 2001-2002.
  - Terms as Council Member, Vice-President, and Past President.
- Referee: *Australian and New Zealand Journal of Statistics*, *Biometrika*

Short CV

Professor Robert Brooks
Associate Dean (Undergraduate)
Faculty of Business and Economics
Monash University

Qualifications: B.Ec. (Hons.), PhD (Monash)

Employment History

Current

Associate Dean (Undergraduate), Faculty of Business and Economics, Monash University, February 2009 to present

Course Director, Bachelor of Business and Commerce, Faculty of Business and Economics, Monash University, February 2008 to present

Professor, Department of Econometrics and Business Statistics, Monash University, February 2005 to present

Previous

Associate Dean (Research Quality), Faculty of Business and Economics, Monash University, May 2006 to January 2008

Head of Faculty (Berwick and Peninsula campuses), Faculty of Business and Economics, Monash University, July 2006 to January 2008

Acting Deputy Dean (Research), Faculty of Business and Economics, Monash University, January 2006 to May 2006

Deputy Head, Department of Econometrics and Business Statistics, Monash University, June 2005 to December 2005

Acting PVC (Design and Social Context), RMIT, July 2004 to August 2004

Dean (Research & Innovation), RMIT Business, March 2004 to June 2004, January 2005

Associate Dean, RMIT Business, August 2003 to December 2003

Acting PVC (Business), RMIT, April 2003 to August 2003, September 2004 to December 2004

Associate Dean (Research), RMIT Business, August 2000 to April 2003 and January 2004 to March 2004

Professor of Financial Econometrics, RMIT Business, January 1999 to January 2005

Head, Research Development Unit, RMIT Business, August 1998 to August 2000

Director, Postgraduate Programs, Economics and Finance, RMIT, August 1998 to August 2000

Associate Professor, Economics and Finance, RMIT, June 1997 to December 1998

Senior Lecturer, Economics and Finance, RMIT, January 1995 to June 1997

Lecturer, Economics and Finance, RMIT, December 1991 to December 1994

Tutor, Economics, Monash University, July 1989 to November 1991

Research Assistant, Economics, Monash University, November 1987 to June 1989

PUBLICATIONS (as at September 2008):

Books

Brooks, R. and Fausten, D. (1998), Macroeconomics In the Open Economy, Longman.

Brooks, R., Morley, C., Kam, B., Stewart, M., Diggle, J. and Gangemi, M. (2003), Benefits of Road Investment to Assist Tourism, Austroads Publication AP-R225/03, Austroads Incorporated.

McKenzie, M. and Brooks, R. (1999), Research Design Issues In Time Series Modelling of Financial Market Volatility, McGraw - Hill Series in Advanced Finance, Vol. 2, McGraw - Hill.

Book Chapters

Bissoondoyal-Bheenick, E. and Brooks, R. (2009), Volatility Asymmetry and Leverage: Some US Evidence, in C.Hoppe, G.Gregoriou and C.Wehn (eds.), Handbook of Model Risk, McGraw-Hill.

Boucher, C. and Brooks, R. (2005), Changing Times, Changing Research, Changing Degrees: Supervising and Managing the First PhD by Project Undertaken in a Business Faculty, in P.Green (ed.), Supervising Postgraduate Research: Contexts and Processes, Theories and Practices, RMIT University Press.

Brooks, R. and Merlot, L. (2005), Changing candidature approval processes: A review of the RMIT Business panel review of candidature process, in P.Green (ed.), Supervising Postgraduate Research: Contexts and Processes, Theories and Practices, RMIT University Press.

Brooks, R. and Sayers, R. (2002), Trends in Printed Matter Exports, in B.Cope and C.Ziguras (eds.), The International Publishing Services Market: Emerging markets for books, from creator to consumer, Common Ground Publishing.

Iqbal, J., Brooks, R. and Galagedera, D. (2009), Asset Pricing with Higher Order Co-moments and Alternative Factor Models: The Case of an Emerging Market, in G.Gregoriou (ed.), Financial Innovations in Emerging Markets, Chapman-Hall/CRC/Taylor and Francis, London, UK.

Iqbal, J., Brooks, R. and Galagedera, D. (2009), Testing the Lower Partial Moment Asset Pricing Model in Emerging Markets, in G.Gregoriou and R.Pascalau (eds.), Handbook of Financial Econometrics, Chapman-Hall/Taylor and Francis, London, UK.

Lim, K. and Brooks, R. (2009), Are Emerging Stock Markets Less Efficient: A Survey of Empirical Literature, in G.Gregoriou (ed.), Financial Innovations in Emerging Markets, Chapman-Hall/CRC/Taylor and Francis, London, UK.

Woodward, G. and Brooks, R. (2009), The Market Timing Ability of Australian Superannuation Funds: Nonlinearities and Smooth Transition Models, in C.Hoppe, G.Gregoriou and C.Wehn (eds.), Handbook of Model Risk, McGraw-Hill.

Conference Papers

Brooks, R. (2003), Time Varying Betas on China's A and B Share Indices, paper presented to the 15th Annual ACESA Conference, Melbourne 2003.

Brooks, R. (2004), Benchmarking University Research Performance Using RRTMR Data, paper presented to the 2004 Quality in Postgraduate Research Conference, Adelaide.

Dimovski, W. and Brooks, R. (2006), Stakeholder and Gender Characteristics of Mining and Energy IPO Boards of Directors, Enhancing Corporate Accountability Prospects and Challenges Conference Proceedings.

Leeprechanon, N., Moorthy, S., Brooks, R. and David, A.K. (2000), A Review of Major Factors in Restructuring Power Markets in Developing Countries, 5th International Conference on Advances in Power System Control, Operation and Management.

Leeprechanon, N., David, A.K., Moorthy, S., Brooks, R. and Liu, F.B. (2001), Restructuring of Electricity Supply Industry in Developing Countries: Lessons from Thailand, Portland International Conference on Management of Engineering and Technology.

Leeprechanon, N., Moorthy, S., Brooks, R., David, A.K. and Wen, F. (2001), Transmission Planning in Deregulated Systems: A Model for Developing Countries, IEEE Porto Power Tech Conference.

Leeprechanon, N., Moorthy, S., Brooks, R., Ellis, M. and Sappakitkamjorn, J. (2002), A Systems Decision Modelling Approach to Electrical Generation Capacity Planning, 12th Annual Symposium International Council on Systems Engineering (INCOSE2002).

Leeprechanon, N., David, A.K., Moorthy, S., Brooks, R. and Nealand, J. (2002), Market Power in Developing Countries, International Conference on Power System Technology (Powercon2002).

Lin, D.Z. and Brooks, R. (2003), Teamwork Model and its Applications to Transaction Cost Economy with a Consideration of Human Behaviour, paper presented to The Management Conference: The Third International Conference on Culture and Change in Organisations.

Russell, R., Brooks, R. and Nair, A. (2006), Evaluating a Financial Literacy Program: The Case of the Australian Moneyminded Program, Proceedings of the Financial Literacy, Banking and Identity Conference.

Unnithan, C., Swatman, P. and Brooks, R. (2002), Do Dot.coms Add Value: A Preliminary Study of the Market Capitalisation of Australian and Indian Telecoms and Banking Sectors, Proceedings of the Thirteenth Australasian Conference on Information Systems, Enabling Organisations and Society through Information Systems, Volume 2.

Major Industry Research Reports

Russell, R., Brooks, R., Nair, A. and Fredline, L. (2005), Saver Plus: Improving Financial Literacy Through Encouraging Savings,
http://www.anz.com/aus/about/saver/Evaluation.asp
Russell, R., Brooks, R. and Nair, A. (2005), Evaluation of Moneyminded: An Adult Financial Education Program,
http://www.anz.com/aus/values/moneyminded/evaluation.asp
Russell, R., Brooks, R. and Nair, A. (2006), Saver Plus – Improving Financial Literacy and Establishing Long Term Saving Habits,
http://www.anz.com/aus/about/saver/Evaluation.asp
Russell, R., Mihajilo, S., Nair, A. and Brooks, R. (2006), Saver Plus –Encouraging Savings and Increasing Financial Capabilities Among Low-Income Families,
http://www.anz.com/aus/about/saver/Evaluation.asp
Russell, R., Brooks, R. and Nair, A. (2006), Evaluation of the Youth Financial Literacy Trial Program,
http://www.anz.com/aus/values/moneyminded/evaluation.asp
Russell, R., Brooks, R. and Nair, A. (2006), Evaluation of MoneyMinded: Reach and Impact
http://www.anz.com/aus/values/moneyminded/evaluation.asp

Russell, R., Mihajilo, S. and Brooks, R. (2007), Saver Plus–Encouraging Savings and Increasing Financial Capabilities Among Low-Income Families
http://www.anz.com/aus/about/saver/Evaluation.asp
Russell, R., Brooks, R, Cabraal, A. and Grahlmann, L. (2007), Evaluation of MoneyMinded: An Adult Financial Education Program
http://www.anz.com/aus/values/moneyminded/evaluation.asp

Russell, R., Doan, M., Harlim, J. And Brooks, R. (2008), Saver Plus Interim Report (Phase III)

Russell, R. Harlim, J. And Brooks, R. (2008), Saver Plus 2008 Follow Up Survey Results

Journal Papers

1991:1(1)

Brooks, R. (1991), A Social Loss Approach to Testing The Efficiency of Australian Financial Futures, *Australian Economic Papers* 30, 192-201.

1992:1(2)

Brooks, R., Faff, R.W. and Lee, J. (1992), The Form of Time Variation of Systematic Risk: Some Australian Evidence, *Applied Financial Economics* 2, 191-198.

1993:2(4)

Brooks, R. (1993) Alternative Point Optimal Tests for Regression Coefficient Stability, *Journal of Econometrics* 57, 365-376.

Fry, T., Brooks, R., Comley, B. and Zhang, J. (1993) Economic Motivations for Limited Dependent and Qualitative Variable Models, *Economic Record* 69, 193-205.

1994:4(8)

Brooks, R. (1994), The Unbiased Prediction Hypothesis in Futures Markets: A Varying Coefficient Approach, *Accounting Research Journal* 7, 33-41.

Brooks, R., Faff, R.W. and Lee, J. (1994) Beta Stability and Portfolio Formation, *Pacific-Basin Finance Journal* 2, 463-479.

Brooks, R. and King, M.L. (1994), Testing Hildreth-Houck Against Return to Normalcy Random Regression Coefficients, *Journal of Quantitative Economics* 10, 33-52.

Brooks, R. and King, M.L. (1994) Hypothesis Testing of Varying Coefficient Regression Models: Procedures and Applications, *Pakistan Journal of Statistics* 10, 301-357.

1995:3(11)

Brooks, R. (1995) The Robustness of Point Optimal Testing for Rosenberg Random Regression Coefficients, *Econometric Reviews* 14, 35-53.

Brooks, R., and Faff, R.W. (1995) Financial Market Deregulation and Bank Risk: Testing for Beta Instability, *Australian Economic Papers* 34, 180-199.

Brooks, R. and Michaelides, P. (1995), Autocorrelations, Returns and Australian Financial Futures, *Applied Economics Letters*, 2, 323-326.

1996:3(14)

Brooks, R., Faff, R.W. and Ariff, M., (1996) The Nature and Extent of Beta Instability in the Kuala Lumpur Stock Market, *Capital Markets Review* 4, 1-14.

Brooks, R. and Sheehan, M. (1996) Forecast Error and Social Loss Approaches to Testing the Efficiency of Australian Financial Futures, *Australian Economic Papers* 35, 132-140.

Fausten, D. and Brooks, R. (1996) The Balancing Item in Australia's Balance of Payments Accounts: An Impressionistic View, *Applied Economics* 28, 1303-1311.

1997:14(28)

Brooks, R. (1997) Using a Sequence of Point Optimal Tests to Select a Varying Coefficient Model, *Communications in Statistics* 26, 671-685.

Brooks, R., Davidson, S. and Faff, R.W. (1997) An Evaluation of the Effects of Major Political Change on Stock Volatility: The South African Experience, *Journal of International Financial Markets, Institutions and Money* 7, 255-275.

Brooks, R. and Faff, R.W., (1997) A Note on Beta Forecasting, *Applied Economics Letters* 4, 77-78.

Brooks, R. and Faff, R.W., (1997) Beta Forecasting in Malaysia: A Note, *Malaysian Management Review* 32, 48-50.

Brooks, R., and Faff, R.W., (1997) Financial Deregulation and Relative Risk of Australian Industry, *Australian Economic Papers* 36, 308-320.

Brooks, R., Faff, R.W., Gangemi, M., and Lee, J., (1997) A Further Examination of the Effect of Diversification on the Stability of Portfolio Betas, *Applied Financial Economics* 7, 9-14.

Brooks, R., Faff, R. and Ho. Y.K., (1997), A New Test of the Relationship between Regulatory Change in Financial Markets and the Stability of Beta Risk of Depository Institutions, *Journal of Banking and Finance* 21, 197-219.

Brooks, R., Faff, R.W. and Josev, T., (1997) Beta Stability and Monthly Seasonal Effects: Evidence from the Australian Capital Market, *Applied Economics Letters* 4, 563-566.

Brooks, R., Faff, R.W. and McKenzie, M. (1997) Bivariate GARCH Estimation of Beta Risk in the Australian Banking Industry, *Accountability and Performance* 3, 81-102.

Brooks, R., Faff, R.W. and Slade, P. (1997), An Investigation of the Level and Stability of Beta Risk Across New Zealand Industries, *Pacific Accounting Review* 9, 37-58.

Brooks, R., Fry, T. and Harris, M. (1997) The Size and Power Properties of Combining Choice Set Partition Tests for the IIA property in the Logit Model, *Journal of Quantitative Economics* 13, 45-61.

Brooks, R. and Lee, J. (1997) The Stability of ARCH Models Across Australian Financial Futures Markets, *Applied Financial Economics* 7, 347-359.

Faff, R.W. and Brooks, R.D., (1997) Further Evidence on the Relationship between Beta Stability and the Length of Estimation Period, *Advances in Investment Analysis and Portfolio Management* 4, 97-113.

McKenzie, M. and Brooks, R. (1997) The Impact of Exchange Rate Volatility on US-German Trade Flows, *Journal of International Financial Markets, Institutions and Money* 7, 73-87.

1998:9(37)

Brooks, R., Berman, G. and Davidson, S. (1998), The Nature and Extent of Revisions to Australian Macroeconomic Data, *Applied Economics Letters* 5, 169-174.

Brooks, R., Berman, G., Davidson, S. and Tan, T.Y. (1998), Is There a Common Response in Australian Bilateral Exchange Rates Following Current Account Announcements, *Applied Economics Letters* 5, 645-648.

Brooks, R. and Faff, R.W. (1998), A Test of a Two-factor APT Based on the Quadratic Market Model: International Evidence, *Studies in Economics and Econometrics* 22, 65-76.

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Nguyen, H., Dimovski, W. and Brooks, R. (2007), Underpricing, Risk Management, Hot Issue and Crowding Out Effects: Evidence from the Australian Resources Sector Initial Public Offerings.

Parkatt, G., Davidson, S. and Brooks, R. (2006), Testing the CAPM and Performance Measurement for Thai Mutual Funds.

Russell, R. and Brooks, R. (2007), An Evaluation of an Interest Free Loan Scheme for Those Affected by Domestic Violence.

Russell, R., Mihajilo, S., Brooks, R. and Musch, S. (2008), Designing Financial Literacy Training Programs for the Small Business Sector: Some Australian Evidence.

Treloar, K. and Brooks, R. (2007), The Participation of Women on the Boards of Cooperative Research Centres.

Zhou, X., Brooks, R. and Chen, G. (2009), Does the Market Reaction to Former Information Influence the Future Voluntary Disclosures of Earnings Forecasts – Evidence from the Chinese A-Share Market.

Journal Refereeing and Thesis Examination

Editorial Board (current)

Accounting & Finance

Editorial Board (previous)

Accounting Research Journal
International Journal of Knowledge, Culture and Change Management

Journal Refereeing

Accounting Research Journal, Accounting & Finance, Agricultural Economics, Agricultural Water Management, Annals of Operations Research, Applied Economics, Applied Financial Economics, Asia Pacific Journal of Economics & Business, Australian Economic Papers, Australian Journal of Agricultural & Resource Economics, Australian Journal of Management, Australian Universities Review, Corporate Governance, Corporate Governance: An International Review, Economic Papers, Economic Record, Economics E-Journal, Emerging Markets Finance and Trade, Emerging Markets Review, European Journal of Finance, European Journal of Operational Research, Financial Markets and Portfolio Management, Financial Review, Global Finance Journal, International Journal of e-Collaboration, International Journal of Emerging Markets, International Review of Economics and Finance, International Review of Finance, International Review of Financial Analysis, Journal of Agricultural and Resource Economics, Journal of Applied Statistics, Journal of Banking & Finance, Journal of Business, Journal of Business Venturing, Journal of Econometrics, Journal of Economic Studies, Journal of Economic Surveys, Journal of Economics and Business, Journal of Empirical Finance, Journal of Futures Markets, Journal of International Financial Markets Institutions & Money, Journal of International Money & Finance, Journal of Quantitative Economics, Managerial Finance, Manchester School, Monash Business Review, Multinational Finance Journal, Pakistan Journal of Statistics, Quantitative Finance, Quarterly Review of Economics and Finance, Review of Pacific Basin Financial Markets and Policies, Review of Quantitative Finance and Accounting, Science of the Total Environment, Studies in Economics and Econometrics.

Thesis Examination

PhD

Australian National University, Edith Cowan University, Griffith University, LaTrobe University, Monash University, Nanyang Technological University, Queensland University of Technology, University of Melbourne, University of Queensland, University of Southern Queensland, University of the Sunshine Coast, University of Sydney, University of Western Australia, Victoria University

1. Supervision of postgraduate research students.

PhD students

Main Supervisor – Completed: (13)

Berman, G. A Charity Case – Efficiency and Accountability of Nonprofit Welfare Organisations in Australia, Economics and Finance, RMIT, 2001.

Bissoondoyal-Bheenick, E., Sovereign and Australian Credit Ratings: Determinants and Valuation Effects, Economics and Finance, RMIT, 2004.

Chan, D. The Role of Information In Stock Pricing In The Hong Kong Stock Market, Economics and Finance, RMIT, 1998.

Diggle, J. When Cash Is King – The Optimal Management of an Asset Allocation to Cash, Economics and Finance, RMIT, 2002.

Gionea, J. Trends/Prospects In The Global Grain Sector: The Opportunities For Australia's Grain Industry, Economics and Finance, RMIT, 2003.

Guo, H. The Chinese initial public offering market: underpricing, duration to listing and hot issue cycles, Econometrics and Business Statistics, Monash University, 2009.

Iqbal, J. Asset Pricing on the Karachi Stock Exchange, Econometrics and Business Statistics, Monash University, 2008.

Lambrick, S. An Assessment and Test of the Arbitrage Pricing Theory in Australia: 1974 to 2000, Econometrics and Business Statistics, Monash University, 2009.

Lim, K. An empirical analysis of the weak-form efficiency of stock markets, Econometrics and Business Statistics, Monash University, 2009.

Lin, D. Investment Decision Making Under Uncertainty: A Residual Character Approach, Economics and Finance, RMIT, 1998.

Loh, J. A Framework for the Valuation of Biotechnology Companies, Econometrics and Business Statistics, Monash University, 2007.

McKenzie, M. Australian Exchange Rate Volatility: Modelling, Forecasting And Assessing The Impact On Trade Flows, Economics and Finance, RMIT, 1997

Sokulsky, D. An Empirical Investigation into the Price Effects Associates with Constituent Changes to Australian Equity Indices, Economics and Finance, RMIT, 2002.

Associate Supervisor – Completed: (18)

Anderson, J. Trading Rules and Money Management, Economics and Finance, RMIT, 2002.

Coate, B. Australian Indigenous and Non-indigenous Art at Auction, Economics and Finance, RMIT, 2009.

Davidson, S. South African Corporate Structures In An Agency Theory Framework, Economics and Finance, RMIT, 1999.

Di Iorio, A. An Analysis of the Exchange Rate Exposure of the Australian Equities Market, Economics and Finance, RMIT, 2002.

Gangemi, M. Modelling Regional Economic Development, Economics and Finance, RMIT, 2008.

Glasson, S. Censoring Regression Techniques for Credit Scoring, Statistics, RMIT, 2007.

Hart, K. Modelling The Asset Allocation Process And The Effectiveness Of Models Through Time, Communications And Informatics, VUT, 2000.

Jens, P. Valuations and Business Models for Biotechnology Companies, Economics and Finance, RMIT, 2007.

Jugurnath, B. An Analysis of an Integrated Tax System in APEC, Economics and Finance, RMIT, 2005.

Lai, E. The Role of Return Skewness In Financial Modelling: Some International Evidence, Economics and Finance, RMIT, 2000.

Leeprechanon, N. A Pricing Optimisation Model For Transmission Services Open Access In The Competitive Electricity Supply Industry In Thailand, Electrical Engineering, RMIT, 2003.

Luo, L. Business and Economic Forecasting in Australia, Econometrics and Business Statistics, Monash University, 2008.

Maldonado, D. Knowledge Development Between Industries and Universities, Management, RMIT, 2005.

Masters, T. Demand and Supply for the Creative Arts in Rural and Regional Victoria, Economics and Finance, RMIT, 2007.

Parkatt, G. The Role Of Equity Factors In Explaining The Cross-sectional Variation In Stock Returns In The Thai Capital Market, Economics and Finance, RMIT, 2002.

Ragunathan, V. Integration Of And Correlations Between National Stock Market Indicies, Economics and Finance, RMIT, 1999.

Wang, Y. Development of China's Capital Markets, Economics and Finance, RMIT, 2006.

Yip, A. A Case Based Reasoning Approach to Business Failure Prediction, Business Information Technology, RMIT, 2005.

Main Supervisor – In Progress: (2)

Irawan, B. Development of bond market in East Asia as a policy response to financial crisis, Econometrics and Business Statistics, Monash University.

Treloar, K. Challenges in Early Stage Commercialisation and Entrepreneurship in Australia, Econometrics and Business Statistics, Monash University.

Associate Supervisor – In Progress: (3)

Jutasompakorn, P. Forecasting the Financial Crisis, Accounting and Finance, Monash University.

Muth, R. International Real Estate Investments in a Mixed-Asset Portfolio, Accounting and Finance, Monash University

Vaz, J. The Behaviour of Interest Rates and Financial Institution Returns, Accounting and Finance, Monash University.

DBA Students

Main Supervisor – Completed: (1)

Dimovski, B. Characteristics Of Initial Public Offerings In Australia 1994 to 1999: Recent Evidence of Initial Day Underpricing and Longer Term Underperformance, Management, RMIT, 2002.

Associate Supervisor – Under Examination: (1)

Lekkumporn, P An exploration of personal values as antecedent of gift-giving behavior, Marketing, Monash University.

Master of Philosophy (Research) Students

Associate Supervisor – Completed: (1)

Nurjannah, Asset Pricing in the Indonesian Stock Market, Econometrics and Business Statistics, Monash University, 2009.

Associate Supervisor – In Progress: (1)

Ting, S. Essays in Financial Econometrics, Econometrics and Business Statistics, Monash University.

UNITED ENERGY
Distribution
United Energy Distribution Pty Limited
ABN 70 064 651 029

Registered Office
- Level 3, 501 Blackburn Road
- PO Box 449
- Mt Waverley Vic 3149 Australia
- Telephone (03) 8540 7800
- Facsimile (03) 8540 7899

17th September 2010

Our Reference: UE-SU-01

By email: Neil.Diamond@buseco.monash.edu.au

Dr Neil Diamond
Room 674, Building 11E
Department of Econometrics and Business Statistics
Monash University
CLAYTON VICTORIA 3800
Australia

Dear Dr Diamond,

Supplementary expert report on the value of imputation credits

The Australian Energy Regulator (**AER**) is currently conducting its five-yearly review of pricing proposals submitted by the five Victorian electricity distribution businesses, United Energy, Citipower, Powercor, Jemena and SP Ausnet. As part of the review process, the AER must determine an appropriate return on capital, which is a function of the valuation of dividend imputation credits, also referred to as gamma. The AER has taken account of a number of dividend drop-off studies in its consideration of the value of gamma, including:

- A 2006 study by Beggs and Skeels;[1] and
- Empirical analyses undertaken by SFG Consulting in January and February 2010[2]

We ask that you provide incisive analysis and commentary in relation to the following propositions:

1. "As a statistical construct, the joint confidence region calculated and plotted by SFG cannot be used to reject the parameter estimates derived by Beggs and Skeels (2006)".

   - Does the joint confidence region in effect "accommodate" the parameter estimates obtained by Beggs and Skeels (2006)?

[1] Beggs, D. J. and Skeels, C.L., (2006), 'Market arbitrage of cash dividends and franking credits', *Economic Record*, 82 (258), 239 – 252.

[2] SFG, *Response to the AER Draft Determination in relation to gamma*. Report prepared for ETSA Utilities, 13th January 2010. SFG, *Further analysis in response to the AER Draft Determination in relation to gamma.* Prepared for ETSA Utilities, 4 February 2010

2. "The SFG parameter estimates change from one discrete time period to the next because of multicollinearity. The parameter estimates are unstable and imprecise."

3. McKenzie and Partington (2010, pp.46) have made the following statement:

   - "We believe that multicollinearity is a serious problem for dividend drop off studies and the results of SFG and Beggs and Skeels (2006) cannot be reliably interpreted in the presence of multicollinearity. Further, until serious consideration is given to this issue, reliable decomposition of the partial effect of cash dividends and franking credits will remain elusive."

Guidelines in preparing your report

Attached are Expert Witness Guidelines issued by the Federal Court of Australia. Although this brief is not in the context of litigation, the Victorian electricity distribution businesses are seeking a rigorously prepared independent view for use in the context of regulatory decision making and you are requested to follow the Guidelines to the extent reasonably possible in the context.

In particular, please:

Identify your relevant area of expertise and provide a curriculum vitae setting out the details of that expertise:

1.1.1. only address matters that are within your expertise;

1.1.2. where you have used factual or data inputs please identify those inputs and the sources;

1.1.3. if you make assumptions, please identify them as such and confirm that they are in your opinion reasonable assumptions to make;

1.1.4. if you undertake empirical work, please identify and explain the methods used by you in a manner that is accessible to a person not expert in your field;

1.1.5. confirm that you have made all the inquiries that you believe are desirable and appropriate and that no matters of significance that you regard as relevant have, to your knowledge, been withheld from your report; and

1.1.6. please do not provide legal advocacy or argument and please do not use an argumentative tone.

Yours sincerely,

Jeremy Rothfield
Regulatory Economist

FEDERAL COURT OF AUSTRALIA

Practice Note CM 7

EXPERT WITNESSES IN PROCEEDINGS IN THE FEDERAL COURT OF AUSTRALIA

1. 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)).

2. 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[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.

Guidelines

1. General Duty to the Court[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[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[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.

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[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].

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

[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]

[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]

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[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 (see 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[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.

M E J BLACK
Chief Justice
25 September 2009

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