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Jim Cox
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Independent Pricing and Regulatory Tribunal
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7 February 2005

Dear Jim

AGLGN RESPONSE TO THE DRAFT DECISION ON THE REVISED ACCESS ARRANGEMENT FOR AGL GAS NETWORKS

Please find attached AGLGN's Response to the Draft Decision on the Revised Access Arrangement for AGL Gas Networks.

In this response, AGLGN raises many issues that the Tribunal may feel require further analysis. AGLGN is keen to work with the Tribunal, the Secretariat and/or Tribunal appointed consultants to progress this review to a satisfactory conclusion.

Yours sincerely

David Pringle

Manager Regulatory Affairs, Gas Networks

For and behalf of AGL Gas Networks Limited

AGL GAS NETWORKS

Access Arrangement for NSW Network – Response to Draft Decision

February 2005

AGLGN ACCESS ARRANGEMENT

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1 INTRODUCTION

This Submission is in response to the Independent Pricing and Regulatory Tribunal's (IPART's) Draft Decision on the Revised Access Arrangement for AGL Gas Networks (AGLGN) released in December 2004. AGLGN agrees to implement twenty-four of the thirty-eight amendments proposed by IPART in its Draft Decision and propose only the clarification of another five. This submission identifies reasons why AGLGN believe that fourteen amendments requires revision.

The balance of this submission is divided into four major sections.

In Section 2 AGLGN presents additional information relevant to three major issues (the Rate of Return, Capital Redundancy and Ancillary Charges) that AGLGN believe were not given adequate consideration in the Draft Decision.

Section 3 addresses three developments that have arisen during the 2004 calendar year, after AGLGN submitted its Revised Access Arrangement. These issues are:

- the effects that the Metropolitan Water Strategy will have on AGLGN's demand forecast,
- the recovery of the cost of ameliorating the probable damage to the Wilton to Newcastle Trunk Pipeline caused by mines subsidence, and
- the recovery of the cost of the likely implementation of Guaranteed Customer Service Standards.

In Section 4 AGLGN details amendments that are required to the Cost of Service as outlined in the Draft Decision. These four amendments are:

- the inclusion of additional capital and operating costs that will be required to meet changes agreed to the AGLGN demand forecast.
- the inclusion of an allowance IT for capital expenditure incurred during the period 2000 to 2004 which was omitted from the Revised Access Arrangement (AA) but identified during the Total Cost Review.
- the removal from the cost of service of depreciation of land, and
- matters arising from the Energy Consulting Group (ECG) Supplementary Report (working capital & cost of laying mains).

Section 5 summarises AGLGN's response to each of the 38 recommendations in the Draft Decision.

2 ITEMS IN THE DRAFT DECISION REQUIRING FURTHER CONSIDERATION

There are three major issues (the Rate of Return, Capital Redundancy and Ancillary Charges) that AGLGN believe were not given adequate consideration during in the Draft Decision. AGLGN presents additional information on each of those issues.

2.1. Rate of Return

2.1.1. General Comments

The Draft Decision requires AGLGN to amend its Access Arrangement to include an allowed rate of return of 7.0% on a pre-tax real basis. The following response sets out a number of areas where AGLGN is of the view that there is sound evidence supporting a revision of that figure to 7.9%.

AGLGN notes that the Tribunal recognises the issues of uncertainty surrounding the Weighted Average Cost of Capital (WACC) parameters and the estimation of the WACC. This recognition is expressed in the use of ranges for WACC parameters and the consequent range for the WACC estimate. AGLGN now propose the use of a more rigorous approach to dealing with the statistical uncertainties surrounding WACC parameter estimation and application of these to estimate the WACC. This approach, which utilises Monte Carlo simulation, has been developed for AGLGN by Professor Stephen Gray[1] and is discussed below.

A further conceptual issue AGL wishes to raise is the impact of the use of prevailing rates in determining AGLGN's cost of capital and cost allowances that need to be considered particularly in relation to the cost of debt.

In addition to these issues of approach AGLGN raises issues in relation to comments on each of the parameters used to estimate the WACC.

2.1.2. Issues of Approach

2.1.2.1. Statistical Approach to Estimating WACC

In recent work on determining an appropriate value for the rate of return to be used in deriving tariffs, AGLGN has focussed on giving better recognition to the fact that the estimation of the WACC has a significant degree of imprecision and uncertainty. The Capital Asset Pricing Model (CAPM) cannot measure the cost of capital, but only estimate it on the basis of observations of historical relationships and the application of

[1] Professor Gray is Professor of Finance at the University of Queensland and part of the Strategic Finance Group

portfolio theory. In addition, all of the variables to be used in the CAPM and WACC have a degree of measurement error, though some have significantly more than others. The most problematic variables are the Market Risk Premium (MRP) and the equity beta. There is also considerable uncertainty in determining the cost of debt, because debt margins for appropriate benchmark companies are not readily observable.

AGLGN notes that in its decisions the Tribunal has sought to recognise the problem of uncertainty surrounding the WACC parameters through use of parameter ranges and calculation of a WACC estimate range from which it selects a point estimate of WACC using its judgement.

AGLGN has now adopted an approach to estimating an appropriate WACC using a statistical methodology in order to overcome the problem of WACC parameter measurement error. In AGL's view this approach represents a better alternative to use of simple parameter ranges that are not supported by a clear statistical basis. This new methodology recognises the probability distribution of variables that have material uncertainty, and combines them into a probability distribution for the WACC using a Monte Carlo simulation, which is a statistically rigorous methodology.

Monte Carlo simulation is a standard statistical technique that is often employed in standard financial applications. It is demonstrated in basic finance textbooks[2] and has been employed by Australian regulators.[3]

The WACC variables used in AGLGN's Monte Carlo simulation and the appropriate ranges and distribution characteristics are set out in Table 2.1

Professor Stephen Gray proposed the theoretical basis for use of a statistical approach and undertook the Monte Carlo simulation to determine the probability distribution of the WACC for AGLGN. Parameter values and probability distributions were determined based on revised parameter value ranges recommended by KPMG and SFG (Strategic Finance Group). Supporting information on the choice of values and/or probability distributions is contained in the SFG reports that are in Appendix 1.1 and the KPMG report dated February 2004 which AGLGN submitted to the Tribunal in March 2004.

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[2] For example, see Brealey and Myers, Principles of Corporate Finance, 7th ed., 2003, McGraw-Hill, Chapter 10; Grinblatt and Titman, Financial Markets and Corporate Strategy, 2nd ed., 2001, McGraw-Hill, Chapter 22; Ross, Westerfield, and Jaffe, Corporate Finance, 6th ed., 2002, McGraw-Hill, Chapter 8.

[3] For example, the Queensland Competition Authority (QCA) employed Monte Carlo simulation analysis to investigate the appropriate capital structure in two recent determinations, uses Monte Carlo simulation to evaluate wharf movements and costs in its recent Dalrymple Bay Coal Terminal Draft Determination, and notes in the review of its WACC framework that Monte Carlo simulation is a technique that is also relevant in relation to parameter estimation and WACC.

Table 2.1

AGLGN WACC VARIABLES	
Variable	**Value / Distribution**
Nominal Risk Free Rate	5.31%[1]
Implied Inflation Rate	2.53%
Real Risk Free Rate	2.71%[2]
Market Risk Premium	Mean: 6.0% Standard Deviation: 1.8% Normal Distribution
Equity Beta	0.9 – 1.1 Uniform Distribution
Gearing	60%
Debt Margin	1. 64 – 1.79%[3] Uniform Distribution
WACC (80th percentile of distribution)	7.9%
Gamma	10 - 50%

Notes:
1. 20-day average of index-linked bond yields as at 14 January 2005.
2. 20-day average of nominal bonds yields as at 14 January 2005.
3. Based on 20-day average of debt spreads from CBA Spectrum and Bloomberg for BBB and BBB+ bonds as at 14 January 2005

The Monte Carlo simulation undertaken by SFG has produced a probability distribution for the WACC with a median of 7.3%, a minimum of 5.4% and a maximum of 9.2%. SFG has identified a range of percentiles between the 75th and 80th that it considers appropriate for the purposes of determining a regulatory WACC.

Based on the analysis by SFG in its report in Appendix 1.1 AGLGN considers this range as the most appropriate range for the following reasons:

- As identified by the Productivity Commission in its reports on the National Access Regime[4], if the regulatory WACC is set too low, this will act as a deterrent to efficient investment. In this report, the Productivity Commission recommended that Part IIIA of the Trade Practices Act be amended to include pricing principles which would, among other things, state that regulated access prices should be:

    - set so as to generate expected revenue across a facilities regulated services that is at least sufficient to meet the long-run costs of providing access to those services; and
    - include a return on investment commensurate with the regulatory and commercial risks involved.

Substantially the same pricing principles (which have been endorsed by the Commonwealth Government) are repeated in the Productivity

[4]Productivity Commission (2002) "Review of the National Access Regime" September 2002, page 338

Commission's report on the Gas Access Regime. The National Access Regime report explains the rationale behind these principles[5] as being to "set a relatively clear floor to revenue allowed within the access regime to facilitate investment in the essential service". In addition, revenue should be related to costs, "but in a way which provided headroom for revenue and prices to be above costs provided that this did not significantly impede efficient use of the service." The underlying understanding behind these principles is that there is much more to be lost in terms of economic efficiency and welfare by an under-estimate of costs than by an over-estimate. Use of a WACC estimate between the 75th and 80th percentiles in establishing the regulated cost of capital is consistent with these principles. The use of the median or 50th percentile provides only a 50 percent chance that the regulated allowance will be sufficient to enable AGLGN to meet its actual cost of capital. AGLGN submits that given the economic risks this probability is too low.

AGLGN submits that an important component of the long-term interests of consumers requires that the returns available from infrastructure investment are sufficient to ensure the continued viability of service providers and to provide the appropriate incentives for future investment. Whether the regulated return is sufficient to achieve these objectives must be assessed against the service provider's true cost of funds. In practice, business cases for new investment are made by assessing the likelihood that the new investment will generate a return that exceeds the relevant cost of funds. The methodology proposed in AGLGN's statistical approach is designed to assist regulators to make exactly this assessment – it quantifies the probability that a particular regulated WACC provides a return that is sufficient to cover the true cost of funds. In this sense, the proposed methodology assists the Tribunal in the implementation of its responsibilities under the Code.

Moreover, the proposed methodology is really nothing new. All Australian regulators recognise that there is uncertainty involved in estimating several WACC parameters. It is also quite standard to recognise this uncertainty by assigning a reasonable range for these parameters[6]. The proposed approach simply uses standard statistical techniques to produce a full probability distribution for the WACC of an efficient benchmark firm in a manner that is entirely consistent with the parameter ranges that have been specified for the uncertain WACC parameters. The framework for estimating parameters and calculating WACC is unchanged – all that is proposed is an examination of how different parameter values affect the WACC.

Research described in the SFG report provides strong evidence that corporations set their hurdle rates for investments at a significant margin above their cost of capital. The use of a regulatory cost of capital, which provides a better than even chance of it being high enough to cover the business' true cost of capital is consistent with corporate practices for investment. More importantly, it will also provide better incentives for efficient investment.

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[5] Ibid, page 330

[6] In fact, IPART does so quite explicitly.

While the exact point on the distribution that is the appropriate landing is open to debate, AGLGN has adopted the 80th percentile in the distribution as the appropriate WACC value (ie 7.9%). This results in a WACC that is only slightly higher than the WACC approved in the 2000 Access Arrangement Final Decision and takes account of the unusually low prevailing risk free rates. This value means that there is an 80% chance that AGLGN's WACC will not be underestimated. Conversely there is a 20% chance that it will be underestimated.

SFG has also applied the Monte Carlo simulation to the parameter values proposed by the Tribunal in the Draft Decision (adapted to use appropriate probability distributions) the result would be a distribution of mean 6.5 %, minimum value of maximum value and 80th percentile of 7.1%.

The follow table sets out the Draft Decision parameter values[7] (adapted for use in the Monte Carlo simulation) and Monte Carlo simulation results.

Table 2.2

DRAFT DECISION WACC VARIABLES	
Variable	**Value / Distribution**
Nominal Risk Free Rate	5.4%
Implied Inflation Rate	2.5%
Real Risk Free Rate	2.8%
Market Risk Premium	Mean: 6.0% Standard Deviation: 1.8% Normal Distribution
Equity Beta	0.8 – 1.0 Uniform Distribution
Gearing	60%
Debt Margin	1. 145 – 1.245% Uniform Distribution
WACC (80th percentile of distribution)	7.1%
Gamma	30 - 50%

The results of this analysis produce a WACC that is similar to that determined for the Draft Decision. Even if the Draft Decision parameters were accepted there are significant advantages to the regulator, the service provider and other participants. The approach is more rigorous, transparent and reduces the risk of arbitrariness associated with the regulator having to make judgements about where it should land in the estimated range.

[7] Note that this analysis assumes a normal distribution for the MRP which is not explicit in the Draft Decision

The rationale set out above for use of the statistical approach and for the selection of the 80th percentile is consistent with each of the tariff principles in section 8.1 of the Gas Code. The rationale is also consistent with the following elements of section 2.24 of the Gas Code:

(a) the Service Provider's business interests and investment in the Covered Pipeline;
(d) economically efficient operation of the Covered Pipeline;
(e) the public interest including the public interest in having competition in markets (whether or not in Australia);
(f) the interests of Users and Prospective Users; and

It is also a matter that the Tribunal may consider relevant under section 2.24 (g) any other matters that the regulator considers are relevant.

In summary, AGLGN submits that use of a statistically based approach centred on use of a Monte Carlo simulation presents an important opportunity for regulators and regulated businesses to simplify regulatory decision-making about WACC and reduce one element of regulatory uncertainty. It also provides a rational basis for responding to the problem associated with underestimation of costs (and consequently providing insufficient incentives for investment) that has been identified in literature on regulatory economics and particularly by the Productivity Commission.

AGLGN recognises that the statistically based approach represents a change from its Access Arrangement proposal and the Tribunal's approach. However, AGLE submits that this approach represents an appropriate development from previous approaches and requests that the Tribunal give full consideration to the use of the statistical approach proposed by AGLGN.

2.1.2.2. Use Of Prevailing Rates

The approach adopted by the Tribunal and other regulators to determining the risk free rate has been the use of the prevailing market rates at the time of the Final Decision, considering that this is in the interests of stakeholders over the long term. AGLGN accepts that there are benefits to the use of the 20-day average of bond rates as being an appropriate approach and has applied it in its revised Access Arrangement.

However, in this proposal AGLGN has identified two aspects of the use of prevailing market rates that are not addressed in the Draft Decision. These issues are:

- The need for an allowance for supply and demand in debt markets because the use of prevailing rates implies refinancing of debt by gas businesses at the time of the review coming into effect. The raising of debt at the beginning of the new regulatory period is likely to result in costs of hedging - whether index-linked or nominal - and an allowance needs to be provided for this cost. KPMG's February 2004 report sets out the rationale for an inclusion of such costs suggesting that an

amount of 20 – 50 basis points is appropriate based on evidence from the 2001 Victorian EDPR[8]. KPMG has recently indicated[9] that an allowance of 25 – 35 basis points is more appropriate based on estimates for the incremental costs associated with capacity shortfalls for index-linked bonds estimated by Westpac[10]. AGLGN is now including an allowance for this cost of 25 – 35 basis points in the debt margin.

- The need for an allowance that reflects the fact that the Tribunal will make is Final Decision around April 2005 about three months before the Decision takes effect. There is significant scope for the risk free rate to move from the level that will exist in April to July when prices will apply. As the current yield on indexed bonds is at the lowest level in the last 10 years the risk is that future movements in bond rates will be upwards rather than downwards and the relatively rapid downwards movements in bond rates experienced in 2004. For example, rates reduced by 0.465% over three months during the period from 29 July (3.275%) to 29 October (2.810%). The potential for increases in the risk free rate remains a risk for gas businesses. Mechanisms for hedging against this risk are not presently clear; however, it is a potential cost that must be borne by AGLGN.

  It would be a mistake to suggest that this cost is implicit in the equity beta, apparently because it is assumed to be a form of inflation hedge as AGLGN is referring to the movement in the real risk free rate rather than the nominal risk free rate that are not inflation-driven. AGLGN submits this cost needs appropriate debate and consideration and that an allowance in the WACC for potential movement in the risk free rate may be the simplest solution.

2.1.3. Issues in relation to particular WACC parameters

2.1.3.1. Market Risk Premium (MRP)

The Draft Decision accepts AGLGN's proposed range for the MRP of 5.5 – 6.5%.

AGLGN notes the report included with the submission by Energy Markets Reform Forum[11] as a response to AGLGN's revised AA. This report, which suggests that the current MRP may be as low as 3%, relies on an inaccurate understanding of the reliability of the long term historical MRP measurements compared to alternative methods of estimating MRP

[8] AGL Gas Networks - Weighted Average Cost of Capital, report by KPMG, February 2004, page34

[9] AGL Electricity Limited, Weighted Av. Cost of Capital, October 2004 by KPMG at http://www.esc.vic.gov.au/apps/page/user/pdf/AppendixK_WeightedAverageCostCapitalKPMG_Oct04.pdf

[10] Westpac letter, dated 19 July 2001 at http://www.esc.vic.gov.au/docs/electric/21westpac.pdf

[11] Further Capital Market Evidence in relation to MRP and Equity Beta, by Headbury Partners P/L and Bob Lim & Co P/L

including forward looking methods. It is incorrect to suggest that long term historical measurements are less reliable than short-term measurements or forward looking methods. The reliability of long-term historical measurements is clearly greater than the other methods.

The choice of a value for the MRP centred around 6.0% as proposed by AGLGN in its Access Arrangement must be considered appropriate, and is in fact conservative (on the low side) as the long term historical measurements support a range of 6.0 – 8.0%. Use of a mean of 6.0% more than adequately allows for any potential downward trend in the MRP suggested by short term measurements (with large standard deviations) or forward looking methods (with their inherent unreliability).

In adopting the statistical approach to estimating WACC, AGLGN is proposing an MRP which continues to be centred around a mean of 6.0%, but with a normal distribution and a standard deviation of 1.8%. This distribution inherently describes the MRP (as measured) and is founded on historic data.

AGLGN submits that the Tribunal should accept the statistical re-expression of the MRP AGLGN is now proposing. However, if the Tribunal were to adopt a traditional non-statistical approach, there is a strong case for extending the upper limit of the range to avoid underestimation. Given the very wide statistical uncertainty of this measurement there is a very strong probability that if the upper limit is not extended then the allowed rate of return will be below the actual cost of capital.

2.1.3.2. Equity Beta

The Draft Decision has adopted an equity beta range (on 60% gearing) of 0.8 – 1.0. Apart from one explainable exception[12], the Tribunal's Draft Decision on the range of equity beta is the lowest yet adopted by an Australian regulator in a final decision for gas or electricity infrastructure.

In its revised Access Arrangement AGLGN proposed an equity beta (assuming 60% gearing) of 0.9 - 1.1, that is centered around 1.0. In applying the statistical methodology this range is presented as a uniform probability distribution in the range 0.9 to 1.1. AGLGN's proposed probability distribution reflects:

- Its view that there is no sound basis for a deviation from an equity beta oriented around 1.0 as generally accepted in recent regulatory decisions.

[12] The QCA decided on an equity beta of 0.71 in its 2001 determination for Queensland electricity distribution. The QCA has revised this parameter in its December 2004 Draft Determination recognising the beta estimates over the period. In that Draft Determination the QCA has accepted the recommendation of ACG that "the equity beta of the average Australian DNSP is 1.0 assuming 60% gearing" but has adopted a beta of 0.9 given the specific circumstances surrounding Queensland DNSP's.

- Even the use of an equity beta 1.0 is uncertain and a distribution around this estimate is statistically appropriate.

AGLGN has observed the recent analyses by regulators of apparent trends in the betas of comparable businesses, which suggest that the betas have declined over the past 3 to 5 years. AGLGN has sought advice from Stephen Gray of the University of Queensland and Strategic Finance Group (SFG) on the correctness of these analyses. Professor Gray's report will be provided to the Tribunal in the near future.

This report demonstrates that a proper understanding of the statistical inferences that can be drawn from recent studies of betas for energy utilities does not provide a sound basis for deducing that betas have reduced.

Instead, the report shows:

- the significant difficulties associated with measurement of beta and the high levels of imprecision that need to be properly reflected in estimates of beta and reflected in the estimation of an appropriate regulatory WACC, and
- that continued use of an equity beta of 1.0 is supported.

AGLGN also notes that Allen Consulting Group (ACG)[13], after completing related but different analysis to Stephen Gray, concluded:

> *"We believe that the equity beta of the average Australian DNSP is 1.00 assuming 60% gearing."*

In concluding their findings on beta ACG expressed the view that:

> *"…the empirical evidence, together with the desirability of maintaining stability in regulatory decisions across time and in consistency in regulatory decisions across companies justifies the use of an equity beta of 1.00 (for a gearing level of 60%) for the average regulated electricity distributor."*

AGLE submits that in the light of Stephen Gray's report (supported by ACG's analysis) there is no sound basis to change the value of 1.0 for the mean of the equity beta and that AGLGN's uniform probability distribution of 0.9 and 1.1 should be adopted.

2.1.3.3 Debt Margin

2.1.3.3.1 Estimates of Debt Spreads

The Draft Decision adopts CBASpectrum service data as the basis for determining debt spreads that are a significant element of debt margins.

[13] Queensland Distribution Network Service Providers – Cost of Capital Study, December 2004 by The Allen Consulting Group, page 51.

AGLGN has become concerned about the accuracy of the CBASpectrum service for determining debt spreads for long term debts (ie 5 to 10 years) and suggests that other evidence should be given greater weight. AGLGN notes a report by NERA[14] that clearly identifies underestimation of debt spreads by CBASpectrum.

In recent reports for the QCA[15] and ERA[16] Allen Consulting Group (AGC) has identified Bloomberg as providing a similar service to CBASpectrum for estimating debt spreads. In addition, AGC identified Snowy Hydro as the longest corporate bond traded in the market (8.5 – 8 year maturity). Further evidence on debt spreads was provided by ActewAGL to the ICRC[17] with a quote for BBB corporate from Westpac Institutional Banking as part of its Access Arrangement review. AGC has also considered a number of other debt raisings which are more difficult to compare because they are either of shorter term or because they involve floating rates and are not easily related to Government Bonds rates.

Table 2.3 summarises values for debt spreads for each of the sources identified above. AGLGN has formed the view that this presents evidence that CBASpectrum significantly underestimates debt spreads and that the understatement is at least 20 basis points for BBB bonds and at least 25 basis points for BBB+ bonds.

Table 2.3 – Debt Spreads

	CBA Spectrum		Bloomberg[18]		Westpac IB	Snowy Hydro
	Estimate (bp)		Estimate (bp)		Estimate (bp)	Actual (8 yr) (bp)
Date	BBB	BBB+	BBB	BBB+	BBB	BBB+
13 August 2004	113	103	130.9[2]	125.0[2]	139 - 154	128
27 October 2004	110	100.7	137.0[2]	129.3[1]	N/A	127.1[3]
20 day av (27/10/04)	N/A	100.7	N/A	127.3[1]	N/A	125.7[3]
14 January 2005	111	101	135.6[2]	128.6[2]	N/A	119

Notes:
1. AGC estimates of bond spreads interpolated from Bloomberg A and BBB fair market curves.
2. AGLGN estimates of bond spreads extrapolated and interpolated to be consistent with the AGC methodology.
3. AGC spreads for Snowy Hydro are 3.9 basis points less than figures AGLGN has obtained from Bloomberg. We have used AGC's figures here.

[14] Estimating the Debt Margin for ActewAGL, February 2004 by NERA.
[15] Queensland Distribution Network Service Providers – Cost of Capital Study, December 2004 by The Allen Consulting Group.
[16] Electricity Networks Access Code 2004: Advanced Determination of a WACC Methodology, January 2005 by The Allen Consulting Group.
[17] ActewAGL response to the ICRC's Draft Decision, August 2004.
[18] Bloomberg estimates of fair market curve debt spreads for some BBB and all BBB+ bonds have been interpolated by AGLGN and AGC.

Table 2.4 shows the differences between CBASpectrum debt spread estimates and those of Bloomberg and the other sources of evidence on debts spreads.

Table 2.4 – Differences in Debt Spread Estimates

	CBASpectrum to Bloomberg (bp)		CBA Spectrum to Westpac I/B (bp)	CBA Spectrum to Snowy Hydro (bp)
DATE	**BBB**	**BBB+**	**BBB**	**BBB+**
13 August 2004	17.9	22.0	26 - 41	25.0
27 October 2004	27.0	28.6	N/A	26.4
20 day av (27/10/04)	N/A	25.0	N/A	25.0
14 January 2005	24.6	27.6	N/A	18.0

The NERA report to ActewAGL provides an explanation for the understatement of debt spreads by CBASpectrum. It appears that CBASpectrum applies a methodology where it replicates the curve shape of higher rated bonds (AAA, AA etc) in developing the curve of spreads for lower rated bonds (BBB, BBB+ etc). The specific data for Snowy Hydro and the Westpac IB quote support this explanation and indicates that the shape of the CBASpectrum curve is flatter between 5 and 10 year than occurs in practice.

As a result of this evidence AGL has updated its estimates for debt spreads to reflect CBASpectrum's estimates at 14 January 2005 for BBB and BBB+ bonds and adjusting them upwards by 20 and 25 basis points, giving spreads of 126 and 131 basis points for BBB and BBB+ respectively.

2.1.3.3.2 Debt Raising Costs

The Tribunal has accepted an allowance of 12.5 basis points for debt raising costs. AGLGN is of the view that this remains a reasonable estimate of debt raising costs for a BBB to BBB+ rated company.

2.1.3.3.3 Hedge Costs

We refer to two of three elements of debt raising costs in our discussion in Section 3 above on Use of Prevailing Rates. In summary AGLGN submits that allowances should be included in the debt margin for:

- expanded credit spreads or inflation hedging, and
- timing difference between the date of Final Decision and the date of commencement of the regulatory period.

2.1.3.4 Gamma

The Draft Decision accepts AGLGN's proposed value range for gamma of 0.3 to 0.5.

Since its original revised Access Arrangement proposal AGLGN has received advice from Professor Stephen Gray on the most recent research on gamma. Professor Gray has provided a report[19] (Appendix 1.2) which presents new, robust and authoritative evidence that the correct value of gamma is much more likely to be 0.0 rather than 0.5.

Professor Gray's paper does a number of significant things:

- It corrects analysis of data from work by Officer and Hathaway.
- It presents two new papers including one by Cannavan, Finn and Gray (2004) that has been peer reviewed and published in a tier 1 international journal.
- It provides a clear map of the logic of arguments that lead to its conclusions in the light of new and existing evidence.

AGLGN submits that Stephen Gray's research paper provide a strong rationale for accepting a gamma of 0.0. Use of a gamma of zero however would be a significant move away from regulatory practice over the past six years and AGLGN accordingly propose a reduction of gamma to a range of 0.1 to 0.5.

2.1.4 Conclusions

In summary AGLGN submits the following in relation to the estimation of WACC:

- The statistical approach based on the Monte Carlo simulation methodology proposed by AGLGN provides a more rigorous approach for handling the uncertainty and imprecision which is a necessary part of the estimation of the WACC in a regulatory context. Importantly it provides a transparent and rigorous approach to overcoming the problems associated with underestimation of costs identified by the Productivity Commission and others. AGLGN submits this approach should be adopted by the Tribunal.
- The market risk premium adopted by the Tribunal should reflect the wide uncertainty in its measurement and that a mean less that 6.0% is unsustainable. If the Tribunal elects not to adopt a statistical approach then the appropriate range for the MRP should be 5.5% to 7.5%.

[19] The Value of Imputation Franking Credits: Gamma Report for AGL in Relation to ESC Electricity Distribution Review October 11, 2004 at http://www.esc.vic.gov.au/apps/page/user/pdf/AppendixMpt1_ValueGammaSFG_ConsultOct04.pdf

- Properly (ie statistically) interpreted market data provides no basis for adopting an equity beta mean less than 1.0.
- The debt margin allowed by Tribunal should reflect:
    - estimation errors in CBA Spectrum debt spreads in the range of at least 20 – 25 basis points, and
    - allowances for costs associated with acquiring debt at prevailing rates of the order of 25 – 35 basis points, and
    - an allowance or potential increase in the risk free rate between the date of the Commission's Final Decision and the commencement of the new tariffs (1 January 2006) should be included.
- There is important new evidence that gamma is much more likely to be 0.0 than 0.5.

2.2 Redundancy of the Wilton / Wollongong Pipeline

In the Draft Decision the Tribunal propose that $2.1m or 20% of the value of the Wilton to Wollongong pipeline be removed from the capital asset base of the pipeline due to a reduction in the volume of gas transported by that pipeline since 2000. AGLGN maintain that this proposal contains a number of significant flaws which can be summarised as:

- This proposal gives no recognition of the role that this pipeline fulfils in providing security of supply to the Wollongong region.
- This proposal gives no recognition of the role that this pipeline fulfils in providing a balancing (swing) service to the Wollongong region. This service is currently provided at no charge.
- The proposed amount to be removed from the capital base does not equitably represent the reduction in the value of the optimised pipeline.
- There is no evidence that the Tribunal in proposing this capital redundancy has (as required by the Code[20]) taken the capital redundancy mechanism into account in the determination of the rate of return and the economic life of assets.
- The Draft Decision exaggerates the impact the proposed redundancy will have on users.

2.2.1 Security of Supply

The question of capital redundancy in the Wilton to Wollongong pipeline has arisen due to reduced contracted volumes in the pipeline following the construction of the Eastern Gas Pipeline (EGP). Following the construction of the EGP however the Wilton to Wollongong pipeline now fulfils two separate roles. It acts as the primary source of supply for those users sourcing gas from Wilton and it plays a significant role in providing security of supply to those users sourcing gas from the EGP.

Should there be any problems in the EGP supply chain then that portion of pipeline now proposed to be written off as redundant would be essential in

[20] National Third Party Access Code for Natural Gas Pipeline Systems section 8.27

maintaining supply to those Wollongong users useing the EGP as their source of gas.

Even under normal operating conditions the Wilton to Wollongong pipeline often transports more gas on a daily basis to meet shortfalls in supply from the EGP than it transports for users contracted through Wilton. This role balancing the daily requirements of the Wollongong network section is discussed in more detail below. It is AGLGN's understanding that this throughput was not considered by MMA in its report on the Wilton to Wollongong pipeline.

The significant role that the Wilton to Wollongong pipeline plays in providing security of supply to the Wollongong region must not be overlooked. This issue is very similar to the issue of security of supply to the Sydney region. In the Draft Decision, the Tribunal has accepted ECG's recommendation that expenditure of $51.6m to improve security of supply to the Sydney region through the Sydney Primary Loop Project is prudent and efficient.

2.2.2 Balancing Service

The Wilton to Wollongong pipeline provides a daily service to all users in the Wollongong network section of ensuring that total inputs each day equals total daily withdrawals and therefore ensuring that supply can be maintained without disruption. This balancing service is required as the second pipeline supplying Wollongong, the EGP pipeline (except in the case of Bluescope Steel) supplies a quantity predetermined by nominations rather than supplying actual daily requirements of its customers.

This role for the Wilton to Wollongong pipeline is analogous to, and an extension of, the role played by the Moomba to Sydney Pipeline (MSP) in providing a swing gas service to Wilton. The owner of the MSP is able to recover the cost of transporting this swing gas through the purchase by AGLGN of balancing gas at Wilton and the resale of this gas to out of balance Network Users.

AGLGN has not previously charged for this service, and this role of the Wilton to Wollongong pipeline has not been recognised by either users or regulation. Nor has the use of it for this service been paid for by Users.

While AGLGN is not proposing to include a charge for this include this service as part of this review, AGLGN should not be further penalised by a write-down in the regulatory value of this pipeline.

2.2.3 Value of the Proposed Redundancy

In calculating the value for the re-optimised pipeline, the Tribunal has accepted MMA's methodology of valuing the optimised diameter using the unit rates that were applied to determine the Initial Capital Base (ICB).

AGLGN maintain that while the units rates used to determine the replacement cost of the Wilton to Wollongong pipeline during the 2000 AA review may have been adequate to determine the total cost of that pipeline as part of a network that is over 22,000 km long (and which covers a variety of terrain) it is not acceptable for valuing a specific 32.8 km section of pipeline in a known location with known physical characteristics and covering a route with known difficult landform characteristics. To support this position AGLGN had the optimised replacement cost valued assuming a variety of pipe diameters.

Appendix 2 contains an independent engineering report on the replacement cost of an optimised Wilton to Wollongong to pipeline. The results are summarised in table 2.5.

Table 2.5 – Comparison of Pipeline Valuations

	Diameter	ORC	DORC 1/7/2005
MMA valuation	350mm/250mm	$13.2m	$10.6m
	250 mm/250mm	$10.6m	$8.4m
Coraldeen valuation	350mm/250mm (interpolated)	$19.7m	$12.8m
	250 mm/250mm	$16.8m	$10.9m

There are two significant results of this study:

- The actual replacement cost based on the actual characteristics of the pipeline in question are considerably above the theoretical rates used in the ICB valuation.
- The actual replacement cost based, even for the re-optimised pipeline remains above the regulatory value of the pipeline.

AGLGN does not accept the position put by the Tribunal in the Draft Decision[21] that to consider the current optimised replacement cost in deciding whether to reduce the value of a pipeline is, in effect revaluing the pipeline after the ICB has been established.

In contrast, AGLGN put the position that the valuation of the current depreciated optimised replacement cost above the regulatory value is strong evidence that the pipeline should not be further written down.

2.2.4 Impact on the Regulatory Rate Of Return and the Economic Life Of Assets

The Code[22] requires that before approving a Reference Tariff that includes a capital redundancy mechanism the Relevant Regulator must take into account the uncertainty such a mechanism would cause and the effect that uncertainty would have on the Service Provider, Users and

[21] IPART Draft Decision section 7.6
[22] National Third Party Access Code for Natural Gas Pipeline Systems section 8.27

Prospective Users. The Code goes further to say that if such a mechanism exists then the determination of the rate of return and the economic life of assets should take into account the resulting risk and cost to the Service Provider.

To AGLGN's knowledge, IPART is the only regulator that has exercised its discretion to introduce a capital redundancy clause into the Access Arrangement of a gas distribution network and to now propose to activate that clause in an Access Arrangement review.

The activation of the Capital Redundancy mechanism adds significantly to the risk involved in incurring prudent and efficient investment in gas distribution infrastructure. As required by the Code, THE TRIBUNAL cannot impose that additional risk without considering that additional risk in determining the Rate of Return and economic asset lives. In the Draft Decision there is no apparent allowance for this additional risk that is not required by other regulators.

2.2.5 Impact on Tariffs for Users of the Pipeline

In the Draft Decision the Tribunal appear to be of the belief that the proposed capital redundancy would result in a noticeable reduction in tariffs for users of the pipeline[23] while having a minor negative impact on AGLGN.

In fact the major individual beneficiaries of any write-down of the Wilton to Wollongong pipeline are contract customers in the Wollongong region and the total annual reduction in tariffs to be apportioned amongst that group of customers is approximately $0.030m. The maximum benefit to any individual customer would represent an estimated reduction in delivered gas price of less than 1%.

In contrast, the proposed write-down would reduce the economic value of the network to AGLGN by $2.1m.

2.2.6 Capital Redundancy Summary

There is a serious lack of equity that accompanies the write-down of an asset that is already valued well below its depreciated optimised replacement cost and which plays an integral role in maintaining security of supply to the Wollongong region. When this is considered together with the lack of any consideration of the additional risk to AGLGN as required by the Code and the minimal impact on tariffs for users of the pipeline, AGLGN submits that the Tribunal must reconsider its recommendation to write-down the value of the Wilton to Wollongong pipeline.

2.3 Ancillary Charges

[23] IPART Draft Decision section 7.6

In the Draft Decision[24] the Tribunal considered that the charges for Ancillary Services proposed by AGLGN would be reasonable if they were well specified and reflected the costs that AGLGN would be likely to incur in providing each individual service.

At the time that the Tribunal requested AGLGN to specify and substantiate the costs associated with these Ancillary Services, AGLGN was in the process of negotiating the details of these Ancillary Services with Network Users.

The results of subsequent analysis of these issues are set out in Appendix 3.

[24] IPART Draft Decision section 13.4.14

3 ISSUES ARISING SUBSEQUENT TO THE REVISED ACCESS ARRANGEMENT SUBMISSION

This Section addresses three developments that have arisen during the 2004 calendar year, after AGLGN submitted its Revised Access Arrangement.

3.1 Review of Water Saving Device Impacts

In July 2004, after MMA had completed its review of AGLGN's demand forecast, the New South Wales Government foreshadowed plans to introduce tighter water restrictions including new rules regarding the retro-fitting of existing structures with water efficient showerheads and tap aerators. This was in addition to the BASIX requirements for new dwellings. These plans were released in greater detail in October 2004.

The effect of water saving measures on the demand for natural gas to heat hot water was an issue on which MMA and AGLGN could not reach agreement during MMA's review of AGLGN's demand forecast. This lack of agreement was largely due a lack of authoritative studies on the issue at the time of the review.

Following the release of the statements by the State Government it became apparent to AGLGN that this issue would become much more significant over the proposed regulatory period than earlier thought. AGLGN began work with the Institute for Sustainable Futures (ISF) to verify its earlier estimates and to quantify the effects of the new Government initiatives. An interpretation of ISF studies had been used by MMA to refute earlier AGLGN forecasts.

As a result of this undertaking, AGLGN submits two items the Tribunal's attention which impact the decision:

1. The NSW State Government announcement of the Metropolitan Water Strategy. As a result, AAA water saving devices will now also impact existing homes.
2. ISF estimates of the impact of AAA water saving devices to hot water.

The following sub-sections outline the impact of both of these changes to the draft decision.

3.1.1 Metropolitan Water Strategy

The Metropolitan Water Strategy (MWS) announced by the NSW State Government has the objective to meet Sydney's current and future water requirements. It has been announced by the NSW government that one course of action to achieve this is through a reduction in current water consumption via AAA water saving devices in existing dwellings.

ISF has provided a report to the NSW government regarding the MWS prior to its announcement, but this report has not yet been made public. AGLGN engaged ISF to provide a forecast of the uptake of AAA water saving devices under the MWS. AGLGN believe this is the best information now available.

ISF provided two mechanisms that the state government would employ. Firstly "retrofit", which is an extension of the current AAA retrofit scheme managed by Sydney Water, which would increase the uptake from 50,000 to 96,000 households per annum until July 2007. Secondly "retrofix", which would require any dwelling sold to be pre-sale certified for AAA water saving devices.

3.1.2 Review of Impact of AAA Water Saving Devices

AGLGN has engaged ISF to review AGLGN position on the hot water saving of AAA water saving devices. This was undertaken after discussions with ISF and determining that ISF had both data not in the public domain and recent papers that could provide a better estimate of the impact of AAA water saving devices utilising measured data.

The conclusion from ISF was that AGLGN position on the reduction in hot water usage of water saving devices should be reduced from 28% to 23% for new dwellings, and retrofitting existing dwellings should be a 19% reduction in hot water used per dwelling.

3.1.3 Modelling

Given both these changes, AGLGN have remodelled the impact of AAA water saving devices for both the changes since AGLGN's submission.

The MWS impact modelling is based on the ISF forecast of uptake of AAA Water Saving Devices and the ISF estimate of a retrofit reducing the hot water by only 19%. It incorporates the existing impact of the average 50,000 retrofits performed by Sydney Water per annum.

The review of the impact of AAA water saving devices on new dwellings utilises the same modelling performed by AGLGN for its submission, except the front-end calculations. These calculations determined the impact of AAA water saving devices on hot water usage, and have been replaced with the ISF estimate of 23% for new dwellings.

The results of the modelling are summarised below.

Modelling Impact – Change in Cumulative Residential Load [TJ]							
	2005	**2006**	**2007**	**2008**	**2008**	**2010**	**Total**
MWS Impact	-25	-75	-125	-146	-167	-188	-703
Change AAA Impact New Dwellings	23	50	78	106	135	165	534
Net Change	-2	-25	-47	-40	-32	-24	-168

As the above table illustrates, there is a slight change in the residential load forecast. The final outcome is shown in the following table.

Residential Market Load [TJ]	2005	2006	2007	2008	2008	2010	Total
Draft Decision	21,957	22,975	23,999	25,039	26,094	27,168	125,275
Net Change	-2	-25	-47	-40	-32	-24	-168
Revised Load Forecast	**21,955**	**22,950**	**23,952**	**24,999**	**26,062**	**27,144**	**125,107**

AGLGN agree that the demand forecasts set out in Table 6.2 of the Draft Decision represented the best forecast at the time those forecasts were made given the data then available. However, those forecasts must be altered to incorporate these latest findings if it is to represent the "best forecast arrived at on a reasonable basis" given the subsequent developments.

3.2 The Pass Through of the Cost of Ameliorating the Probable Damage to the Wilton To Newcastle Trunk Pipeline Caused By Mines Subsidence

AGLGN is currently incurring and will continue to incur significant costs to ameliorate probable damage to the Wilton to Newcastle Trunk Pipeline due to ground movements resulting from underground mining activities.

With both the mining activities and the work on the Trunk Pipeline proceeding for much of the proposed regulatory period, the costs of this work are difficult to forecast. In addition AGLGN is currently engaged in legal proceedings attempting to recover the costs of this work.

As a consequence, the prudent and efficient costs that will be borne by AGLGN are both difficult to determine and commercially sensitive.

AGLGN propose that the AA be amended to add an additional "Cost Pass Through Event" to Section 3.11 (c). This event is a "Mines Subsidence" event and is defined as:

"A Mines Subsidence Event means any event that gives rise to expenditure incurred by the Service Provider to:

- Lessen the likelihood of damage to the Network caused by actual or planned underground mining activities;
- Repair damage to the Network caused by underground mining activities; and
- Recover costs associated with mines subsidence from third parties associated with the mining activities.

Where that expenditure cannot be recovered directly from third parties associated with the mining activities."

3.3 The Pass Through of the Cost of the Likely Implementation of Guaranteed Customer Service Standards (GCSS's)

In April 2004, IPART submitted its final recommendations on GCSS's, which set the minimum standards for energy utilities in a range of areas to the Minister of Energy and Utilities.

In its Final Report on NSW Electricity Distribution Pricing in June 2004[25] the Tribunal introduced a specific cost pass through mechanism for costs incurred in the possible additional expected payments linked to GCSS's.

The Department of Energy, Utilities and Sustainability released an Issues Paper in November 2004 concerning practical issues around the implementation of t Tribunal's Recommendations.

In light of these developments AGLGN propose that the AA be amended to add an additional sub-point to Section 3.11 to deal with the introduction of Guaranteed Customer Service Standards. It is proposed to add:

> "3.11 (d) Guaranteed Customer Service Standards
>
> AGLGN may vary Reference Tariffs to recover:
>
> - Payments linked to Guaranteed Customer Service Standards as a result of IPART's recommendations to the Minister for Energy and Utilities to introduce payments linked to network reliability.
> - Efficient costs associated with the administration of Guaranteed Customer Service Standards as a result of IPART's recommendations to the Minister for Energy and Utilities to introduce payments linked to network reliability.

[25] IPART NSW Electricity Distribution Pricing 2005/05 to 2008/09 section 11.

4 ADJUSTMENTS REQUIRED TO THE COST OF SERVICE

There are a small number of amendments required to the Cost of Service calculation as outlined in the Draft Decision. These amendments are:

4.1 The Inclusion of Additional Capital and Operating Costs that will be Required to Meet Changes Agreed to the AGLGN Demand Forecast.

During the review by MMA of the demand forecast proposed by AGLGN, there were a number of changes agreed between MMA, AGLGN and ultimately the Tribunal. The most notable change was a significant increase in the forecast number of new sites connecting to the Network, and consequent growth in forecast Tariff Market volume due to the release by BIS Shrapnel during 2004 of higher growth forecasts for the Sydney Housing Market.

In the Draft Decision, the Tribunal issued a draft amendment requiring AGLGN to adopt demand forecasts that included this significant increase in customer site numbers.[26] There is no mention in the Draft Decision however of adjustments required to the Cost of Service necessary to the meet Capital and Non-Capital costs required to service this demand forecast.

In Attachment 4, the Capital Costs required to service the revised demand forecast are detailed. This analysis is based on the demand forecast set out in Table 6.2 of the Draft Decision and the unit rates as reviewed by ECG and determined prudent and efficient in Section 7.3 of the Draft Decision.

Similarly the Non-Capital Costs shown in Table 9.3 of the Draft Decision need to be adjusted to reflect the recommended demand forecasts. Non-Capital Costs for the proposed regulatory period must be recalculated to incorporate the revised demand forecast, using the formula proposed by IPART in its 2000 Final Decision[27], as varied in the AGLGN Revised AA Submission.[28]

[26] IPART Draft Decision section 6.5
[27] IPART Final Decision 2000 section 9.4.4
[28] AGLGN Revised AAI 2003 section 6.4.2

4.2 The inclusion in the Cost of Service of IT capital expenditure incurred during the period 2000 to 2004 which was omitted from the Revised AA Submission but identified during the Total Cost Review.

During the review by ECG of capital expenditure for the period 2000 to 2004 IT capital expenditure projects were identified that had been omitted from AGLGN's 2003 Revised AA Submission. In its final report ECG concluded that $23.9m of this expenditure was consistent with the level and type of expenditure that would be expected of a prudent service provider acting efficiently in accordance with good industry practice.[29]

This expenditure is acknowledged by IPART in its Draft Decision.[30] However there is no recognition of this expenditure in the Cost of Service calculation in the Draft Decision. Section 8.1 (a) of the Code requires that AGLGN be provided with the opportunity to earn a stream of revenue that recovers the efficient cost of delivering Reference Services.

This capital expenditure was incurred by AGL Corporate Services Ltd not AGL Gas Networks Ltd. Therefore rather than including this expenditure in the Regulatory Asset Base, AGLGN propose that a non-capital cost be included in the Cost of Service representing an "IT Utilisation Fee" payable by AGLGN to AGL Corporate Services. The IT Utilisation Fee will be an actual cost incurred by AGLGN throughout the new Regulatory Period as billing procedures between AGL Corporate Services and AGLGN have now been put in place.

This charge has been calculated to have the same effect on the Cost of Service as if the expenditure had been included in the Regulatory Asset Base. Details of this calculation are shown in Attachment 5.

4.3 The Removal from the Cost of Service of Depreciation of Land

In calculating the "return on" and "return of" capital expenditure for the proposed regulatory period in the Draft Decision, the Tribunal were unaware that the Regulatory Asset Base contained approximately $7m of land acquired prior to 1996 for the construction of regulator stations and operating depots.

As this land was grouped together with relatively short-lived assets such as motor vehicles, plant and equipment it is assumed in the Draft Decision calculations that these assets would be fully depreciated over the proposed regulatory period.

[29] ECG Review of AGLGN Access Arrangement for IPART section 7.7.4
[30] IPART Draft Decision section 7.3.2

The calculation of the Roll Forward of the Regulatory Asset Base should be amended to remove the depreciation of land with a resulting decrease in the Cost of Service.

4.4 Matters arising from the ECG Supplementary Report (Working Capital & Cost Of Laying Mains)

Shortly before the release of the Draft Decision, ECG released a Supplementary Report to its review of the AGLGN Access Arrangement. There are two errors in the way this report is included in the Draft Decision.

Firstly the report[31] sets out that AGLGN ultimately agreed that ECG's assumption that "working capital be calculated assuming that capital cost creditors of 27.5 days of annual capital expenditure" is fair and reasonable. However the Cost of Service calculation and Amendment 13 of the Draft Decision[32] incorporates AGLGN's previous position that capital cost creditors of 10.5 days of annual capital expenditure is fair and reasonable. The Cost of Service should be reduced accordingly.

Secondly there is a basic error in one of the recommendations in the Supplementary Report concerning the cost of supervising mains construction in built up areas.

In preparing the forecast capital costs and in recording actual capital costs, AGLGN determined the total supervision costs for all minor capital works and then allocated that cost to cost categories in proportion to base level costs for each category. As the efficient level of base cost of laying mains in built up areas are more than double the cost of laying mains in new estates, then the supervision cost allocated to built up areas will be more than double the level of supervision cost allocated to New Estates.

ECG concurs with AGLGN that the proposed base cost of laying mains in both built up areas and new estates are prudent and efficient and also that the level of cost in built up areas is more than double the cost in new estates.

ECG however recommends the supervision cost of constructing mains in built up areas should be reduced to a level not be more than double the supervision cost of constructing mains in new estates as the level of supervision required is not more than double. At face value this recommendation appears reasonable but given AGLGN's costing procedures it is invalidly applied by ECG to AGLGN's analysis.

The phenomenon identified by ECG is not a consequence of an inefficient level of cost, but merely a product of AGLGN's costing procedures. If ECG's recommendation is to be adopted, then the cost of all other minor

[31] ECG Review of AGLGN Access Arrangement for IPART – Supplementary Report section 1.4
[32] IPART Draft Decision chapter 9

capital works must be increased to exactly offset the reduction to the cost on constructing mains in built up areas.

This error is applied in the Draft Decision to both prudent capital expenditure for the current regulatory period and forecast capital expenditure for the proposed regulatory period and AGLGN submit that it should be corrected.

5 SUMMARY LIST OF REQUIRED AMENDMENTS

Amendment 1 - Postcode boundaries (chapter 3)

The explanatory note in Attachment 3 to the access arrangement information must be amended to clarify the basis for the postcodes in that Attachment, and to make specific reference to AGLGN's proposed amended Station Identification codes.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 2 - Definition of 'coastal' and 'country' (chapter 3)

Definitions for 'coastal' and 'country' must be included in the access arrangement information and AGLGN must ensure that these and other associated terms are used consistently throughout the access arrangement information.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 3 - Definition of 'diversified MDQ' (chapter 3)

A definition for 'diversified MDQ' must be included in the access arrangement information.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 4 - Correction of delivery pressure data (chapter 3)

Attachment 2 of the access arrangement information must be amended to include the correct minimum delivery pressure of the Wilton-Mt Keira pipeline of 2,800 kpa.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 5 - Revision of the access arrangement information to reflect the draft decision amendments (chapter 3)

The access arrangement information must be amended to reflect the amendments in the draft decision, and to ensure that it contains the most up-to-date information available.

AGLGN Response

As discussed throughout this response AGLGN does not agree to implement all of the draft amendments. AGLGN does however agree to amend the Access Arrangement Information to reflect the most up to date information including the Final Decision and subsequent events.

Amendment 6 - Capital redundancy mechanism (chapter 5)

The capital redundancy mechanism at Section 4.2.1 of the proposed access arrangement must be amended to read as follows:

> ***4.2.1 Capital Redundancy Mechanism***
>
> 1. *The Relevant Regulator may reduce the Capital Base with effect from the commencement of the Access Arrangement Period (immediately following the conclusion of the current Access Arrangement Period) if it is of the reasonable opinion that any of the following have occurred in relation to assets comprising some or all of the Capital Base:*
>
>   *(a) the assets have ceased to contribute to the delivery of Services;*
>
>   *(b) the assets have been sold or disposed of by AGLGN or AGLGN has entered into a binding agreement for their sale or disposal; or*
>
>   *(c) the assets have decreased in value because of a decrease in their utilisation resulting from a decline in the volume of sales of this Service, irrespective of whether the decline is also for reasons other than a decline in the value of sales.*
>
> 2. *In determining whether to reduce the Capital Base under paragraph 1, and the amount (to be determined by the Relevant Regulator) by which the Capital Base should be reduced, the Relevant Regulator may take into account:*
>
>   *(a) the value of the assets when the assets were first included in the Capital Base, and their current value;*
>
>   *(b) the value that the assets to be removed from the Capital Base represent as a proportion of the total Capital Base;*
>
>   *(c) the cost to AGLGN of a reduction in Total Revenue resulting from a reduction of the Capital Base;*

(d) *the impact of a reduction of the Capital Base on Tariffs paid by Users;*

(e) *the objectives and principles of the Code; and*

(f) *any other factors that in the reasonable opinion of the Relevant Regulator are relevant and not inconsistent with the Code.*

AGLGN Response

The wording proposed by AGLGN as a Capital Redundancy Mechanism was an adaptation of those words directed by IPART in its 2000 Final Decision. At no stage has AGLGN agreed that such a mechanism was appropriate.

If a Capital Redundancy Mechanism is however to be directed by the Tribunal, then AGLGN propose that clause 1(C) as proposed in the Draft Decision would better reflect AGLGN's understanding of the Tribunals intent if the wording were altered to:

"the assets have decreased in value because of a decrease in their utilisation resulting from a decline in the volume of sales of this Service, irrespective of whether the decline in value is also for reasons other than a decline in the volume of sales."

Amendment 7 - Demand forecasts (chapter 6)

The proposed access arrangement must be amended so that the demand forecasts used to determine total revenue and reference tariffs are those submitted by AGLGN in June 2004 (as set out in Table 6.2 of this report)

AGLGN Response

As set out in section 3.1 of this response, AGLGN agree that the demand forecasts set out in table 6.2 of the Draft Decision represented the best estimates given the information available at the time, but must be amended to incorporate subsequent developments.

Amendment 8 - Contracted MDQ for major contract customer demand forecasts (chapter 6)

The proposed access arrangement must be further amended so that demand forecasts used to determine total revenue and reference tariffs for major contract customers are based on these customers' actual levels of contracted MDQ for 2002/03.

AGLGN Response

AGLGN does not agree that this amendment will result in a more reasonable forecast of future demand.

However due to the minimal impact on distribution revenue AGLGN agree to adopt contracted MDQ for 2002/03 as the basis for determining major contract customer demand forecasts.

Amendment 9 - Regulatory asset register (chapter 7)

AGLGN must ensure that its regulatory asset register is consistent with the rolled forward capital base in Amendment 10 of this report.

AGLGN Response

As discussed elsewhere in this response, a number of changes are required to the roll forward capital base in Amendment 10 of this report. However AGL will ensure that (where applicable) the regulatory asset register is consistent with the roll forward asset base contained in the final approved Access Arrangement.

The regulatory asset register will be made consistent with the actual historic data as set out in the final approved Access Arrangement, but actual capital expenditure will replace forecast data as it becomes available.

Amendment 10 - Rolled forward capital base (chapter 7)

The proposed access arrangement must be amended so that the capital base used to determine total revenue and reference tariffs complies with the values set out in Tables 7.10 to 7.17 below:

AGLGN Response

As discussed elsewhere in this response, a number of changes are required to the roll forward capital base.

Amendment 11 - Pre-tax real rate of return (chapter 8)

The proposed access arrangement must be amended so that the pre-tax real rate of return used in the methodology to determine total revenue and reference tariffs does not exceed 7.0 per cent.

AGLGN Response

AS discussed in Section 2.1 and Appendices 1.1, 1.2 and 1.3 of this report, AGLGN does not agree to this amendment.

Amendment 12 - Non-capital costs (chapter 9)

The proposed access arrangement must be amended so that the non-capital costs used to determine total revenue and reference tariffs comply with the values in Table 9.3 of the Draft Decision.

AGLGN Response

As set out in section 4.1 of this response AGLGN maintain that changes are required to the non-capital costs set out in the Draft Decision.

Amendment 13 - Net working capital (chapter 9)

The proposed access arrangement must be amended so that the working capital used to determine total revenue and reference tariffs is calculated using:

a) tariff and contract debtors at 29 days of distribution revenue (tariff and contract markets);

b) unbilled gas (accrued revenue) at 41 days of tariff market revenue;

c) inventories at no real change from the 2003/04 level;

d) operating cost creditors at 45 days of annual non-capital expenditure;

e) capital cost creditors at 10.5 days of annual capital expenditure.

The rate of return to be applied to the working capital must be 9.7 per cent (nominal pre-tax).

AGLGN Response

AGLGN submit that two amendments are required to this draft amendment:

- capital cost creditors should be increased to 27 days, as discussed in Section 4.4 of this response; and

- the rate of return should be increased in line with Section 2.1 of this response.

Amendment 14 - Number of trunk zones (chapter 10)

The proposed access arrangement must be amended so that the capital and non-capital trunk costs used to determine total revenue and reference tariffs are allocated to contract customers based on the existing seven trunk zones, and the trunk reservation capacity charge and trunk throughput charge is imposed in accordance with customers' use of each of these zones.

AGLGN Response

AGLGN agree to implement this amendment. In conforming to this amendment however AGLGN expresses regrets that in doing so it is agreeing to forgo a one-off opportunity to open up the wholesale gas market in New South Wales. In the longer term this could have been expected to yield considerable benefit to the New South Wales gas consumers.

Amendment 15 - Conditions on user and receipt point swaps within the same trunk zone (chapter 10)

The proposed access arrangement must be amended so that references to conditions on user swaps and receipt point swaps within the same trunk zone are removed.

AGLGN Response

AGLGN does not agree to implement this amendment.

Conditions concerning "Receipt Point Swaps within the same trunk zone" do not need to be removed. With no current examples of multiple receipt points within a single zone then those conditions would simply be inoperative. They would however remain as an option should future receipt points be established within the same trunk zones.

"User Swaps" are only applicable to users of the same receipt point, ie: user swaps would always occur within the same trunk zone irrespective of the number of zones. The amendment proposed by the Draft Decision would have the effect of completely removing user swaps.

Amendment 16 - Allocation of disposals (chapter 10)

The proposed access arrangement must be amended so that the disposals used in the methodology to determine total revenue and reference tariffs are allocated to both tariff market and contract customers in accordance with each customer class' proportion of peak day MDQ on medium pressure assets, however minor that allocation may be.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 17 - Allocation of benefits and costs of future growth (chapter 10)

The proposed access arrangement must be amended so that the incremental benefits and costs of future growth in the contract market used in the methodology to determine total revenue and reference tariffs are allocated to contract customers and the incremental benefits and costs of future growth in the tariff market are allocated to tariff market customers.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 18 - Definitions of 'Tax' and 'Relevant Tax' (chapter 12)

The definition of 'Relevant Tax' in the proposed access arrangement must be amended, and a new definition of 'Tax' must be inserted, as follows:

'Relevant Tax' means any Tax other than:

a) any tax in the nature of an income tax or a capital gains tax;

b) penalties, charges, fees and interest on late payments, or deficiencies in payments, relating to any Tax;

c) stamp duty, or similar taxes and duties; and

d) any Tax that replaces or is the equivalent of or similar to any of the taxes referred to above.

'Tax' means any royalty (whether based on value, profit or otherwise), tax, duty, excise, levy, fee, rate or charge imposed from time to time during the term of this Access Arrangement by any government or any governmental, semi-governmental or other body authorised by law to impose that tax on or to:

a) the Network (or any of its components);

b) the operation of the Network; or

c) the provision of Services by AGLGN.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 19 - Amended gas reconciliation methodology (chapter 12)

If AGLGN wishes the Tribunal to consider an amended gas reconciliation methodology prior to making its final decision, the proposed access arrangement must be amended to include a proposed methodology, trigger mechanism or other revision that would allow for the removal of UAG provisions and costs during the access arrangement period.

AGLGN Response

AGLGN agree to amend its proposed Access Arrangement to allow for the removal UAG provisions and an adjustment to Reference Tariffs should UAG be removed as a network cost during the Access Arrangement period.

Amendment 20 - Definitions of 'Regulatory Event' and 'Change in Tax Event' (chapter 12)

The definition of a 'Regulatory Event' in the proposed access arrangement must be amended to exclude a 'Change in Tax Event'.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 21 - Symmetrical tariff variation methods (chapter 12)

The proposed access arrangement must clarify that tariff variation methods operate symmetrically.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 22 - Exclusion of 'Insurance Event' and 'Unforseen External Event' (chapter 12)

'Insurance Event' and 'Unforseen External Event' must be excluded from the cost pass-through mechanism in the proposed access arrangement.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 23 - Basis for allocating pass through costs (chapter 12)

The proposed access arrangement must specify a cost allocation basis for recovery of pass-through amount (such as allocating costs according to the same allocation methodology used in setting reference tariffs).

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 24 - Notification and approval process (chapter 12)

The notification and approval process for tariff variations in the proposed access arrangement must provide that:

a) when AGLGN proposes to vary tariffs, it is required to provide the Tribunal with notice of 50 business days prior to the effective date of the variation;

b) in accordance with the Code, variations may be initiated by the Tribunal if AGLGN does not provide notice of an event;

c) variations are subject to the Tribunal's approval (deemed or otherwise), and reasonable satisfaction that the variation is based on incremental and efficient costs;

d) variation notices provided to the Tribunal must include:

e) the effective date of the variation; and

f) an explanation of how the proposed variation is consistent with approved variation method;

g) variation notices provided to the Tribunal should include:

h) details of the financial impact on AGLGN with supporting documentary evidence including a demonstration that costs are incremental and efficient;

i) an explanation of how the variation is to be recovered through tariffs.

AGLGN Response

AGLGN expects that there would typically be one variation to Reference Tariffs each year, generally on 1 July. A major determinate of each annual variation in Reference Tariffs will be to incorporate CPI data up until the preceding March Quarter. CPI data for the March Quarter is generally released by the Australian Bureau of Statistics at the end of April each year, leaving approximately 61 calender days or (allowing for public holidays) 40 business days prior to the implementation of the revised Reference Tariffs.

IPART's proposed amendment to require 50 business days notice prior to the effective date of the variation is therefore not practical.

AGLGN maintains its position that it be required to provide the Tribunal with notice of 30 business days prior to the effective date of the variation. Therefore after the release of the relevant data by the ABS this would allow:

- Ten business days for AGLGN to revise the proposed Reference Tariffs;
- Twenty business days for IPART to review the revised Reference Tariffs;
- Ten business days notification to users.

Otherwise AGLGN agree to implement this amendment.

Amendment 25 - Security for payment (chapter 13)

AGLGN is required to specify objective and non-discriminatory criteria related to clause 10, Schedule 2A of its proposed access arrangement as follows:

- *That the amount of any security shall be determined by having regard to user's credit rating, payment history and to be proportionate to the charges for the proposed service.*
- *That the form of security is to be either (a) a parent company guarantee or (b) a refundable deposit or bank guarantee or (c) such other form of security as agreed between the User and AGLGN.*

AGLGN Response

AGLGN believe that this amendment in its current form creates undue commercial risk for the service provider. AGLGN propose the alternative clauses:

- That the amount of any security shall be determined by having regard to user's credit rating, payment history and any additional factors which, in AGLGN opinion, may have a material effect on the user's ability to perform any of its obligations under the service agreement or upon AGLGN's ability to recover any amounts payable or to be payable by the user.
- The amount of security should be proportionate to the charges for the proposed service.
- That the form of security is to be either (a) a parent company guarantee or (b) a refundable deposit or bank guarantee or (c) such other form of security as agreed between the User and AGLGN.
- That includes an obligation on users to provide AGLGN with all information reasonably required to assess credit worthiness in a timely manner.

If the above alternatives are not accepted AGLGN seek an adjustment to the cost pass through mechanism in the Access Arrangement to enable AGLGN to recover losses due to the non-payment by any user, through an adjustment to reference tariffs during the Access Arrangement Period.

Amendment 26 - Responsibility for gas and UAG (chapter 13)

AGLGN is required to amend clause 12, Schedule 2A of its proposed access arrangement such that the provisions relating to responsibility for gas and UAG cease to have effect in the event of a change in the treatment of UAG as a result of new Gas Retail Market Business Rules during the access arrangement period.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 27 - Overruns (chapter 13)

AGLGN is required to amend the provisions in Schedule 2A of the proposed access arrangement relating to overruns to indicate that where a delivery point is served under two or more service agreements then an overrun is only deemed to occur where withdrawals at that delivery point exceed the total for all service agreements of MDQ in any day or MHQ in any hour.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 28 - New receipt points and receipt stations (chapter 13)

AGLGN is required to amend clause 32, Schedule 2A of its proposed access arrangement to limit the ability of AGLGN to recover costs incurred by AGLGN in undertaking works required to enable a new receipt point to be established and integrated into the AGLGN network to those costs reasonably incurred.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 29 - Alteration of receipt points and receipt stations (chapter 13)

AGLGN is required to amend:

- *Clause 33, Schedule 2A of its proposed access arrangement to indicate that AGLGN may require users to make alterations to receipt stations for the purpose of upgrading measurement performance or accommodating changes to gas demand characteristics only to the extent that the alterations are in accordance with good industry practice and/or appropriate Australian and internationally recognised standards and codes.*
- *Clause 34, Schedule 2A of its proposed access arrangement to indicate that AGLGN's rights to recover costs are limited to recovery of costs reasonably incurred.*

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 30 - Suspension of supply (chapter 13)

AGLGN is required to amend clause 49, Schedule 2A of its proposed access arrangement to limit the value of charges imposed on a user in connection with the cessation or suspension of supply to costs reasonably incurred by AGLGN in complying with the request of the user to stop or suspend delivery of gas.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 31 - Liabilities and Indemnity (and gas swap service) (chapter 13)

AGLGN is required to amend Section 2.7 of its proposed access arrangement so that the second sentence in the penultimate bullet point reads:

> *The user will be liable for and indemnify AGLGN against any costs, penalties, expenses or any other loss or damage suffered or incurred by AGLGN arising from inaccurate or misleading information supplied by the user to AGLGN in connection to a Gas Swap, or the users participating in the Gas Swap failing to time and coordinate Gas Swap notifications and gas balancing nominations (made in accordance with Schedule 3) to ensure that their daily withdrawal requirements and completed Gas Swaps reflect their arrangements for delivery of gas to receipt points for each day.*

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 32 - Additional terms and conditions applicable to reference services except tariff services (chapter 13)

AGLGN is required to amend its proposed access arrangement as follows:

- *Clause 3, Schedule 2B must indicate the period over which a service may be continued.*
- *Clause 4, Schedule 2B must indicate that an application of a user for a service in the circumstances contemplated by clause 4 is not subject to the queuing policy of the access arrangement.*
- *To remove reference to Schedule 2B as part of the terms and conditions for the Meter Data Service and Gas Swap Service in Sections 2.6 and 2.7 of the proposed access arrangement.*

AGLGN Response

AGLGN agree to implement this amendment

Amendment 33 - Operational principles (chapter 13)

AGLGN is required to amend Schedule 4 of the proposed access arrangement such that the liability of AGLGN for "any losses, liabilities or expenses incurred by the User and/or the Users' customers arising from load shedding" is limited only in circumstances where AGLGN acts in good faith and in accordance with the principles of the access arrangement.

AGLGN Response

AGLGN agree to implement this amendment.

Amendment 34 - Delivery point, receipt point and nominated delivery points (chapter 13)

AGLGN is required to amend Section 2 of its proposed access arrangement as follows:

- *The terms and conditions for the Local Network Multiple Delivery Point Service and Trunk Multiple Delivery Point Service should be amended to make provision for deletion of delivery points from service agreements during the terms of the agreements.*
- *The terms and conditions for the Trunk Capacity Reservation Service, Trunk Managed Capacity Reservation Service and Trunk Throughput Service should be amended to make it clear that a service agreement for these services may provide for gas to be delivered to only a single delivery point.*

AGLGN Response

As set out in its submission of 1 September, 2004, AGLGN agreed to include provision for the deletion of delivery points during the term of Multiple Delivery Point Service Agreements to reflect current practices in regard to mid term churns. AGLGN proposes that the first bullet point of this amendment is clarified as follows:

The terms and conditions for the Local Network Multiple Delivery Point Service and Trunk Multiple Delivery Point Service should be amended to include mechanisms used in AGLGN's existing service agreements for the deletion of delivery points during the term of the agreement in circumstances of customer churn.

AGLGN agree to implement the second bullet point of this amendment

Amendment 35 - MDQ and MHQ (chapter 13)

AGLGN is required to amend Section 2 of its proposed access arrangement as follows:

- *Sections 2.1, 2.2, 2.3 and 2.5 should be amended to clearly state that AGLGN's obligation to deliver gas extends to MDQ and MHQ and includes any authorised overrun that is expressed as an increase in MDQ and/or MHQ.*

- *Section 2.1 should be amended so as to explicitly indicate that the MDQ under a service agreement for Capacity Reservation Services includes capacity obtained as summer, short term or additional capacity.*

AGLGN Response

AGLGN agree in principle to this amendment but propose that the intent of the amendment would be more clearly met with the following alteration:

- Sections 2.1, 2.2, 2.3 and 2.5 should be amended to clearly state that AGLGN's obligation to deliver gas extends to MDQ and MHQ plus any authorised overrun

- Section 2.1 should be amended so as to explicitly indicate that the MDQ under a service agreement for Capacity Reservation Services includes capacity obtained as summer, short term or additional capacity

Amendment 36 – Summer tranche, short term and additional capacity (chapter 13)

AGLGN is required to amend Section 2.1 of its proposed access arrangement so as to explicitly indicate that additional capacity for Capacity Reservation Services is obtained under an existing service agreement.

AGLGN Response

AGLGN agree to implement this amendment

Amendment 37 - Charges for ancillary services (chapter 13)

AGLGN must remove any reference to charges for ancillary services in its proposed access arrangement until it can substantiate to the Tribunal the cost reflectivity of such charges.

AGLGN Response

AGLGN have provided details of the Ancillary Charges in Section 2.3 and Appendix 3 of this Response.

Amendment 38 - Method to be applied to determine whether an extension or expansion will be treated as part of the covered pipeline (chapter 17)

The first paragraph of the extensions and expansions policy at Section 7 of the proposed access arrangement must be amended to read as follows:

- *The following method shall be used to determine whether an extension or expansion of a Covered Pipeline should be taken to form part of the Covered Pipeline:*

  a) *Subject to this clause, an extension or expansion of a Covered Pipeline will be taken to form part of the Covered Pipeline (and will be treated for all purposes as part of the Covered Pipeline) from the date of completion of the extension or expansion.*

  b) *AGLGN may apply to the Relevant Regulator in writing for a declaration by the Relevant Regulator that paragraph (a) will not apply to the extension or expansion referred to in the application.*

  c) *After considering an application and undertaking such consultation as the Relevant Regulator considers appropriate, the Relevant Regulator must advise AGLGN whether or not it makes the declaration.*

  d) *A declaration may be made on such reasonable conditions determined by the Relevant Regulator and will have the operation specified in the declaration.*

- *An extension includes any pipes laid in NSW in a distribution system owned and operated by AGLGN at any time during the Access Arrangement (where "distribution system" has the meaning given to it in the Gas Supply Act).*

AGLGN Response

AGLGN agree to implement this amendment.

A Framework for Quantifying Estimation Error in Regulatory WACC

Draft report for AGL Gas Networks in relation to IPART 2004 Access Arrangement Review

February 07, 2005

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Executive Summary

This paper has been prepared by Strategic Finance Group for AGL Gas Networks Limited (AGL GN) to submit as part of the consultation process of the Independent Pricing and Regulatory Tribunal (IPART) in relation to the 2004 Access Arrangements Review. It outlines a framework for quantifying the uncertainty surrounding the estimated return on capital – an issue that is particularly important in light of a number of recent legal and administrative decisions. The paper establishes a framework for quantifying the uncertainty in the estimated weighted-average cost of capital (WACC) of a regulated entity. We demonstrate how to identify and quantify the uncertainty in estimates of various WACC parameters and show how this aggregates into uncertainty about the estimated WACC. We also develop a framework for quantifying the uncertainty in the true cost of funds of the regulated entity. In particular, we use standard Monte Carlo simulation techniques to construct a full probability distribution around the WACC estimate. This can be interpreted as a probability distribution of the true cost of funds of an efficient benchmark entity. From this, it is possible to compute the probability that a given regulatory WACC will be insufficient to meet the cost of funds of an efficient benchmark entity. This assists regulators to assess the possible financial impacts of their determinations.

This framework is structured to assist regulators in their obligations under relevant legislation. For example, the National Gas Code (Sec 2.24) requires the relevant regulator to take into account "the Service Provider's legitimate business interests and investment in the Pipeline," "the economically efficient operation of the Covered Pipeline," and "the public interest, including the public interest in having competition in markets (whether or not in Australia)" The framework that is developed in this paper measures the probability that a particular regulated WACC determination will be sufficient to cover the service provider's true cost of funds. The likelihood of the regulator's determination providing a sufficient return on capital is central to the service provider's legitimate business interests and to the public interest in ensuring that the provision of key infrastructure remains a viable business and that the appropriate incentives for future investment exist. Indeed it is difficult to see how the objectives of the Code can be met by a regulator that does not know the likelihood that the regulated WACC will cover the service provider's true cost of funds.

We apply this framework to the gas distribution business of AGL Gas Networks. We construct a probability distribution for the true cost of funds of an efficient benchmark NSW gas distribution business. We show that the mean true cost of funds is 7.3% (median of 7.2%), real pre-tax. There is a 50% chance that the true cost of funds is between 6.7 and 7.8%, and a 90% chance that it is between 6.0 and 8.5%.

We argue that the Tribunal should set a regulatory WACC such that there is at least a 75-80% chance that the allowed return is sufficient to meet the true cost of funds of an efficient benchmark entity. A regulatory WACC of 7.8% provides a 75% chance of being able to recover the true cost of funds. A regulatory WACC of 7.9% provides an 80% chance of being able to recover the true cost of funds.

We argue that this is required to meet the Tribunal's objectives of[1]:

- Providing the Service Provider with **the opportunity to earn a stream of revenue that recovers the efficient costs** of delivering the Reference Service over the expected life of the assets used in delivering that Service;
- Replicating the outcome of a competitive market;
- Ensuring the safe and reliable operation of the Pipeline;
- **Not distorting investment decisions** in Pipeline transportation systems or in upstream and downstream industries;
- Efficiency in the level and structure of the Reference Tariff; and
- Providing an *incentive* to the Service Provider to reduce costs and **to develop the market** for Reference and other Services.

This is also consistent with a number of recent legal and administrative decisions in the Australian regulatory system as well as recent industry reviews conducted by the Productivity Commission. In this regard, we present arguments about the consequences of setting the allowed return too low and evidence about what is required to provide the right incentives for future investment.

[1] National Gas Code, Section 8.1.

We conclude that it is appropriate for the Tribunal to set the pre-tax real WACC in the range of 7.8-7.9%.

1. Overview

The Independent Pricing and Regulatory Tribunal (IPART) is responsible for the economic regulation of gas distribution services in New South Wales. A revised access arrangement is being reviewed by IPART for the next regulatory period which will commence during 2005. IPART has issued its Draft Decision. The objective of the review is to determine the basis on which the gas distribution businesses will be permitted to charge for their services in the next regulatory period, having regard to the level of service required by customers. To achieve this objective, the Tribunal has developed a review framework and the consultation process it will adopt in order to reach a well informed and balanced judgement in determining the price controls. This paper has been prepared for AGL Gas Networks (AGL GN) to submit in response to the Draft Decision as part of the Tribunal's consultation process. It outlines a framework for quantifying the uncertainty surrounding the estimated return on capital – an issue that is particularly important in light of a number of recent legal and administrative decisions.

In the Australian regulatory environment, the regulated firm's revenue requirement is constructed using a building block approach. One important component of the revenue requirement is the return on capital. This often represents 30-40% or more of the regulated firm's revenue requirement. The return on capital is computed as the product of the regulatory asset base (RAB) and the weighted-average cost of capital (WACC). WACC is computed in accordance with one of the possible cost of capital formulas that have been proposed in the corporate finance literature and have been adopted in practice. There are various specifications of WACC depending on whether it is to be applied to real or nominal cash flows and whether various tax effects (notably, the deductibility of interest payments and the potential value of franking credits) are incorporated in the WACC or the cash flows. Whatever the specification that is chosen by the regulator, the WACC is estimated as a mathematical combination of several parameters. Each of these parameters is, itself, estimated with reference to market data.

Most (perhaps all) of these WACC input parameters are unobservable and have to be estimated or inferred from observable data. For example, CAPM betas are usually estimated by regressing the stock returns of comparable listed firms on stock market returns. The estimate of the slope coefficient then forms the basis for an estimate of

beta. Of course, any differences between the comparable firm and the firm being regulated (e.g., a different capital structure) must also be accounted for. The point here is that betas are not *observed* nor *computed*, they are *estimated*. Even with the best of tools, the regulator's estimate of beta may be above or below the true value. No amount of analysis can ever identify the true value—the best that can be done is to identify a probabilistic range within which the true value is likely to lie.

Another example is the market risk premium (MRP)—the expected return on the market portfolio of risky assets in excess of the return on the risk-free asset. The key piece of data used to estimate the MRP is usually the mean of observed premia (stock market index returns less government bond yields) over some historical period. Perhaps the most basic statistical concept of all is that the mean of a sample is an *estimate* of the true value. In a large sample, the true value would be drawn from a normal distribution centered around the sample estimate. Again, we can never hope to identify the true MRP—the best that can be done is to identify a probabilistic range within which the true value is likely to lie. The same issue applies to many other WACC input parameters. These parameters cannot be observed or computed, but can only be estimated—often quite indirectly. For example, the value of franking credits is often inferred from observing how stock prices change on ex-dividend days.

The fact that a number of input parameters cannot be estimated precisely but can only be narrowed to a reasonable range, inevitably means that it is impossible to express the WACC estimate (which is a mathematical aggregation of the input parameters) as a single point estimate. The estimated WACC must be expressed as a reasonable range. The width of this range depends on the aggregated uncertainty of the imprecisely estimated input parameters.

The purpose of this paper is to:

- Identify the sources of uncertainty in estimating WACC parameters.
- Quantify the uncertainty around the estimation of each WACC parameter.

- Demonstrate how uncertainty around each parameter aggregates into uncertainty about the true cost of funds of an efficient benchmark firm and quantify the uncertainty around this true WACC.
- Develop a framework for determining an appropriate regulatory WACC in light of estimation uncertainty.

2. WACC estimation error

2.1. Estimation Error

It is well recognized in corporate finance practice and in the relevant literature that a firm's cost of capital can only be estimated imprecisely. The leading paper on the quantification of this uncertainty is Fama and French (1997), who focus on estimation error in estimating the cost of equity. In particular they note that there can be substantial measurement error associated with estimating a firm's cost of equity. This uncertainty stems from two sources: the risk premium $\left(R_M - R_f\right)$ and the risk loading $\left(\beta\right)$ are both estimated with error. This estimation error means that we cannot be sure of the "true" parameter values. We are able to measure, however, confidence intervals from the estimated parameters' standard errors. To illustrate the issue, and quantify the uncertainty to some extent, Fama and French construct confidence intervals for cost of equity estimates at the industry level.

A further complication arises when we are interested in knowing an individual firm's cost of equity. This arises because industry standard errors for risk loadings are likely to understate the standard errors for individual firms due to the averaging process that a portfolio of firms affords. In this regard Fama and French (1997) state, "…the risk loadings for individual firms or projects are less precise than those of industries, the standard error of costs of equity for firms or projects are even larger."

As a minimum we can examine the effects on industry-average costs of equity resulting from the uncertainty surrounding the estimation of inputs into the cost of equity calculation.

For a variety of scenarios, Fama and French (1997) consider the individual and net contribution of risk factor (MRP) and risk loading $\left(\beta\right)$ uncertainty upon the implied uncertainty in the cost of equity. The results are not encouraging in the quest to precisely quantify a firm's cost of equity.

The authors state that, "large standard errors (in industry costs of equity) are driven primarily by the uncertainty about the true factor risk premiums, with some help from imprecise estimates of period-by-period risk loadings."
Taking the CAPM as our benchmark, the average standard error in the cost of equity resulting from uncertainty in the estimation of the market risk premium alone is at least three percent. The marginal contribution from uncertainty in estimating beta makes the total standard error even greater.

Even starting with the highly unlikely assumption that the risk premium is estimated without error, there is sufficient variation in risk loadings (betas) alone to warrant concern. Fama and French (1997) report results that support a 95 percent confidence interval around the mean cost of equity of more than three percent.

What can we conclude from these results? It is safe to say that the CAPM does not provide any degree of comfort in being able to state precisely and without reservation what the cost of equity actually is. Confidence intervals around the estimated cost of equity are extremely wide. Furthermore, firm specific estimates would have even greater uncertainty than the industry results that are reported. The merits of the asset pricing approach to cost of equity estimation are perhaps best summed up by Fama and French (1997) themselves: "…uncertainty of this magnitude about risk premiums, coupled with the uncertainty about risk loadings, implies woefully imprecise estimates of the cost of equity."

In the Australian regulatory setting, the issue is even broader than Fama and French (1997) suggest. The Australian regulatory setting requires the estimation of a weighted-average cost of capital (WACC). This WACC is computed using a building block approach—the estimated WACC is the compilation of a number of parameters, each of which is measured with some uncertainty. The degree of uncertainty is lower for some parameters (e.g., the risk-free rate) and higher for others (e.g., the market risk premium).

Australian regulators have acknowledged this uncertainty in different ways. IPART, for example, uses a range, rather than a point estimate, for some parameters. IPART then produces a WACC range by aggregating parameters at one end of the range and then at the other. This process acknowledges uncertainty and estimation errors, but falls short of providing a probabilistic framework. Whereas, the process acknowledges the

uncertainty about the aggregated WACC estimate and proposes a range, it provides no direction about where in the range the regulatory WACC should be set, nor any indication about the probability that a particular regulatory WACC is sufficient to cover the entity's true cost of funds.

Other Australian regulators acknowledge that certain input parameters cannot be precisely estimated and propose a range for some parameters. The more common process is for the regulator to then use some discretion or judgment to choose an appropriate point estimate from within the range. This too prevents the estimation uncertainty in the computed WACC from ever being explicitly recognized or properly quantified.

We conclude that:

- **There is significant uncertainty and estimation error involved when estimating a firm's cost of capital. Fama and French (1997) clearly and systematically document this uncertainty. The source of this uncertainty is that building block parameters cannot be estimated with great precision.**
- **A firm's WACC is *estimated*, not *computed*. The true cost of funds of an efficient benchmark firm may be higher or lower than this estimate.**
- **It is particularly important in a regulatory setting to not just recognize the existence of uncertainty and estimation error, but also to quantify it as precisely as is reasonably possible. That is, it is important to quantify the probability that the true cost of funds is higher or lower than the estimated WACC, and by how much.**

2.2. Quantification of Uncertainty

This section describes a process for modeling the uncertainty involved in the WACC estimation process. It also shows how to quantify the extent to which the estimated WACC may differ from the firm's true cost of funds[2].

In particular, we recognize that certain WACC input parameters are imprecisely estimated. For these parameters, we use a range or distribution rather than a point estimate. These parameter estimates and ranges are summarized in Table 1 below. The relevant parameters, data sources, and estimates are all consistent with other submissions to the Review by AGL GN. The main purpose of this paper is not to provide great detail on the selection of parameter estimates and ranges, but to demonstrate that the complex relationships between parameter estimates and estimation uncertainty has a potentially important impact on the aggregated WACC calculation. We focus on how to quantify the impact on the estimated WACC using appropriate statistical techniques.

[2] Throughout this paper we use the term "firm's true cost of funds" to mean the true cost of funds of an efficient benchmark firm. This term should not be read as meaning the actual realized cost of funds of a particular firm.

Table 1: Proposed WACC parameter estimates

Parameter	Symbol	Source	Estimate	Distribution
Real risk-free rate of interest	r_f	Yield on 10-year Government bond (20-day average).	2.71%	—
Capital structure	D/V	Comparables and regulatory decisions.	60%	—
Debt margin	—	BBB-BBB+ corporate bond yields.	1.64-1.79%	Long-term debt spread: Uniform (1.26-1.31%) Demand/Supply Conditions: Uniform (0.25-0.35%) Debt Issuance Costs: 0.125% Fixed
Equity beta	β_e	Comparables and regulatory decisions.	0.9-1.1	Uniform
Market risk premium	*MRP*	Historical stock returns and 10-year govt. bond yields and regulatory decisions.	Mean=6% SD=1.8% [3]	Normal
Value of franking credits	γ	Empirical evidence and regulatory decisions.	0.1 – 0.5	Uniform

2.2.1. Real risk-free rate

The real risk free rate is estimated as the average yield, over the 20-day period prior to the date of the decision, on Index Linked Government Bonds with a 10-year term to maturity. The current benchmark 10-year nominal government bond matures in April 2015. As there is no Index Linked bond with this maturity, an equivalent 10-year Index Linked yield is computed by linearly interpolating between the August 2010 and August 2015 Index Linked Government Bond yields.

2.2.2. Capital structure

There is a wide range of capital structures among comparable gas distribution firms in Australian, U.S. and U.K. markets. On average, these comparables have around 50% debt financing. This issue has been addressed in many Australian regulatory

[3] Normal distribution with mean 6% and standard deviation 1.8%, consistent with historical variation in observed market risk premia.

determinations relating to gas and electricity distribution. Australian regulators have developed a strong precedent for the use of 60% debt as the benchmark financing assumption. As this assumption is reasonably consistent with market practice, we adopt a 60% gearing assumption for our analysis.

2.2.3. Debt margin

The debt margin is a premium that is added to the risk-free rate to estimate the appropriate cost of debt financing. The debt margin reflects the creditworthiness of the entity, supply and demand conditions in the relevant debt markets at the time the debt is assumed to be raised, and any debt raising or establishment costs. Creditworthiness is usually quantified in terms of a credit rating that reflects the business risk of the entity and the benchmark level of gearing. Australian regulatory precedent is to use a credit rating of BBB to BBB+ for a regulated energy distribution business with 60% gearing. This is reasonably consistent with market practice. A number of commercial services provide estimates of the spread between risk-free government bonds and corporate bonds of various ratings. These services essentially use a dataset that contains the actual yields of traded corporate bonds and fit a curve through the available data points. It is not surprising that the estimates of different service providers can vary quite substantially. This is because different curve-fitting methodologies can be used and because the available Australian data is quite thin. For example, over the last six months, debt spreads reported by Bloomberg have been consistently been 20(25) basis points higher than those reported by CBA Spectrum for long-term BBB (BBB+) corporate bonds. Debt spreads sourced from Westpac Institutional banking in relation to long-term BBB corporate bonds are even higher.

In a recent report to the QCA, the Allen Consulting Group (2004, p23) notes that:

> *"While the CBASpectrum estimate of debt margins has been the dominant influence on Australian regulators setting regulatory debt margins, it has come under recent criticism, amongst others by NERA (on behalf of its client ACTEWAGL) which has argued that the CBASpectrum estimates result from an inaccurate, statistically based instrument that does not accord with reality. By way of example, it noted that on February 24, 2004, CBASpectrum estimated that a BBB+ 10 year bond should trade at 100 basis points over the government bond rate. The only bond with a similar maturity actually in the market is Snowy Hydro, which on that date was trading at 137 basis points."*

The NERA report[4] referred to above provides an explanation for the understatement of debt spreads by CBA Spectrum. NERA argues that CBA Spectrum applies a methodology in which the term structure of (more liquid) high-rated bonds (AA and A) is essentially replicated when fitting the term structure of lower-rated bonds (BBB and BBB+). This is likely to arise from the fact that the AA and A corporate bond markets in Australia are more liquid than the market for lower-rated bonds. The result is that the shape of the CBA Spectrum curve for BBB and BBB+ bonds at the longer end (5-10 years) is flatter than occurs in practice. The anecdotal evidence relating to Snowy Hydro and the Westpac Institutional Banking quote are consistent with this explanation.

For these reasons, we adopt a range of 126-131 basis points as our estimate of the long-term BBB-BBB+ debt spread. This computed as the CBA Spectrum estimates of corporate debt spreads on 14 January 2005, adjusted upwards by 20 and 25 basis points for BBB and BBB+ bonds respectively.

In addition, the current demand/supply condition of the market for index-linked bonds (the assumed form of financing) does not favour additional issues. This issue has previously been raised in Australian regulatory determinations. In the Essential Services Commission's 2001 Electricity Distribution Price Review, for example, Westpac Bank noted that "the current capacity within the index-linked market is well short of meeting the funding requirements of the entire electricity distribution business" and that "Westpac's estimate of the incremental costs associated with index-linked funding is of

[4] Estimating the Debt Margin for ActewAGL, February 2004 by NERA.

the order of 25-30 basis points."[5] The market conditions have changed little since that time. Moreover, the alternative strategy of issuing nominal bonds and using some form of derivative securities to hedge inflation risk is itself a costly strategy and self-insurance is, of course, not free. Therefore, a premium of around 25-35 basis points should be added to the corporate bond spread.

Finally, consistent with the Australian Competition Tribunal's (ACT) decision on the GasNet appeal against the ACCC decision on transmission revenues, and with recent Australian regulatory practice, we include an allowance for debt establishment costs. Whereas an allowance of 25 basis points was ultimately adopted in this case, no explanation of the quantification of this amount was made available. Therefore, we have adopted recent Australian regulatory estimates of 12.5 basis points for debt establishment costs.

In summary, the debt margin is estimated as the sum of three components. To the extent that these components are estimated with uncertainty, a range, rather than a precise value, is more appropriate. The range that we have used in the table above reflects the aggregated uncertainty over the appropriate credit rating, the spread to government bonds, the supply/demand conditions in the relevant market and the debt issuance costs.

2.2.4. Equity beta

It is well known that equity betas cannot be *computed* or *measured* but can only be *estimated* from (noisy) market data. Having regard to beta estimates from comparable firms, differences in market and regulatory structures, differences in gearing, and the high degree of estimation uncertainty, Australian regulators have been remarkably consistent in using 1.0 as an estimate of the equity beta for gas and electricity distribution businesses. In almost every Australian gas and electricity distribution determination, Australian regulators have used a 60% gearing assumption and assigned an equity beta of 1.0. The few exceptions have used an equity beta close to 1.0 or a range that contains 1.0.

[5] Westpac letter of 19 July 2000, http://www.esc.gov.au/docs/electric/21westpac.pdf.

Recent statistical estimates of equity betas for some energy firms are low relative to historical averages. However, it must be remembered that these are not computations, but very imprecise estimates. In fact, it is not possible to conclude that the available data supports a conclusion that the equity beta of an Australian gas distribution business is statistically less than one. In addition, the average relevered equity beta of Australian comparable firms has been 1.0 until very recent times, characterized by unusual market circumstances that have a pronounced effect on the way betas are estimated. Also, the relevered equity beta of the much larger set of U.S. comparable firms is very close to 1.0.

For these reasons, and to reflect the uncertainty surrounding estimates of equity betas, we adopt a range of 0.9 to 1.1 for the equity beta. This is consistent with Australian regulatory precedent and with the totality of available market evidence.

2.2.5. Market risk premium

Most Australian regulators adopt a consistent approach to the estimation of the market risk premium, with a value of 6% being adopted in the vast majority of determinations. For example, this value has been used in recent determinations by the QCA, ESC, GPOC, ESCOSA and the ACCC. However, it is clear that the market risk premium is estimated with some uncertainty. The Tribunal has recognised this uncertainty by using a range, rather than a point estimate, for the MRP. Further illustrating the difficulty of precisely estimating this parameter, the Tribunal has used a point estimate of 7% (1997), a range of 5-6% (2000), and a range of 5.5-6.5% (2004) in its last three gas determinations[6]. We propose that this uncertainty and estimation difficulty should be recognized and quantified, and agree that a range around a mid-point of 6% is appropriate. Our proposal is to construct this range using standard statistical tools for quantifying uncertainty.

The Central Limit Theorem of statistics documents that, in a large sample, the estimate of the mean is normally distributed around the true mean. The 120-year sample of historical equity returns relative to the risk-free rate has a mean of 6.5% and the standard error around the mean is 1.8%. Depending on the time period of data that is used, the mean estimate of the market risk premium could be anywhere between 6% and 8%. An

[6] The Tribunal adopted a range of 5-6% in its Electricity Distribution Determination in June 2004.

estimate of 6% for the MRP has been adopted in most Australian regulatory determinations. This is at the lower end of the 6-8% range that is computed as the empirical mean over historical data periods. The adoption of a value at the lower end of this range presumably reflects the weight regulators have given to other forms of evidence (including conceptual arguments about transaction costs, volatility and diversification; survey responses; and predictions from simple dividend discount models). We follow this approach and propose a market risk premium centred around 6%, but that the appropriate statistical measure of uncertainty also be recognized.

Specifically, we propose that the market risk premium be modelled as normally distributed with a mean of 6.0% and standard deviation of 1.8%. In addition, we propose that the distribution be truncated at the 5th and 95th percentiles, (3.04% and 8.95%, respectively). This is done in order to prevent simulated values for the market risk premium being negative, implying an expected return less than the risk free rate, or being a very low number, which results in unreasonably high debt betas.

2.2.6. Gamma

The value of franking credits, gamma, is probably the most contentious of all WACC parameters. The dominant Australian regulatory practice is to set gamma to 0.5, suggesting that franking credits are worth half their face value when created. The Tribunal has traditionally recognised the substantial uncertainty involved in indirectly estimating gamma from market data, employing a range of 0.3 to 0.5. In its most recent decision, the Tribunal used a single point estimate of 0.5,[7] however a range of 0.3 to 0.5 is again proposed in the Gas Networks Draft Decision[8] in line with AGLGN's revised Access Arrangement proposal. However, the most recent empirical evidence, the only evidence published in top-tier journals, and the dominant market practice all suggest that franking credits do not reduce corporate cost of capital. This implies that gamma should be set at zero.

[7] NSW Electricity Distribution Pricing 2004/05 to 2008/09 Final Report.

[8] Revised Access Arrangement for AGL Gas Networks, Draft Decision, December 2004.

The purpose of this paper is not to review the detailed and complex arguments about how to empirically estimate gamma.[9] Rather, the purpose is to recognise that gamma is indirectly and imprecisely estimated. This estimation error or uncertainty, and its inter-relationship with other parameters, should be accounted for in an accepted and robust manner. Therefore, in this paper, we consider a range that is centered around 0.3 (a value that the Tribunal has previously considered), extends up to 0.5 (to incorporate current regulatory precedent), and extends symmetrically down to 0.1 (in light of the most recent empirically sound evidence and market practice).

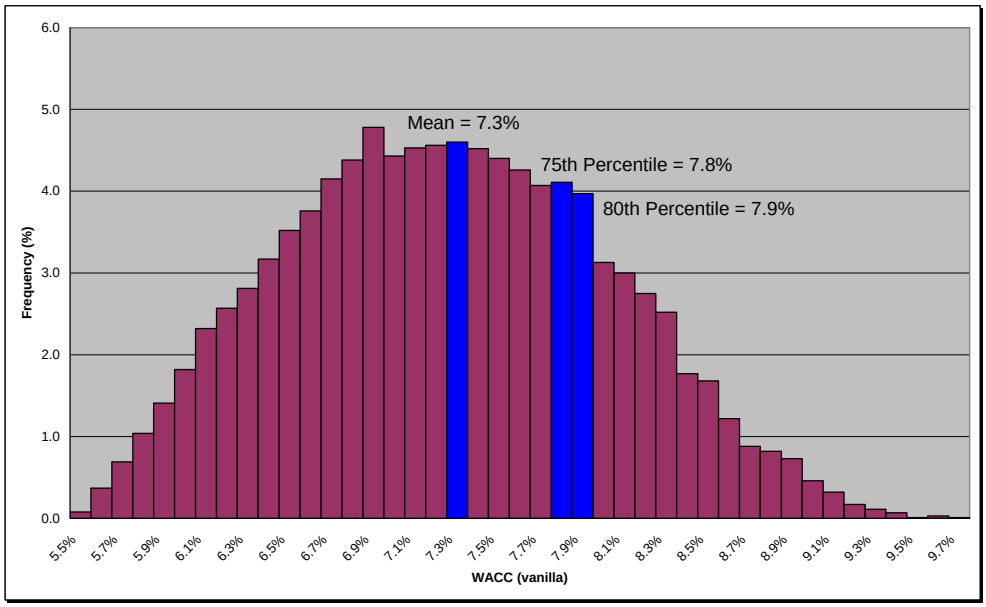
2.2.7. Simulation framework

We model the market risk premium as being normally distributed around 6% and the other parameters for which a range is used in Table 1 are assumed to be uniformly distributed, implying that all points within the range are equally likely. For example, there is an equal chance that the equity beta will be 0.9, 1.1 or any value in between. Other parameters are held fixed at their estimated values.

We then take a random draw from the distribution for each uncertain parameter and compute the resulting vanilla post-tax real WACC. This process is repeated 10,000 times yielding a histogram of WACC estimates, which is illustrated in Figure 1 below.

[9] A comprehensive discussion of estimation and conceptual issues in relation to gamma is contained in our recent submission to the Essential Service Commission's Electricity Distribution Price Review. See the paper "The value of imputation franking credits: Gamma."

Figure 1: Distribution of pre-tax real WACC estimates for 10,000 simulations



The result of this procedure is a mean WACC estimate of 7.3%, with standard deviation of 0.8%.

Figure 1 should be interpreted as a probability distribution of the firm's true cost of funds (pre-tax real WACC). That is, the true equity beta is assumed to be between 0.9 and 1.1, the true market risk premium is assumed to come from a normal distribution with mean 6% and standard deviation 1.8%, and so on. This all aggregates up to a probability distribution for the firm's true cost of funds.

At this stage, it should be noted that the proposed approach involves nothing new. All Australian regulators recognize that there is uncertainty involved in estimating several WACC parameters. It is also quite standard to recognize this uncertainty by assigning a reasonable range for these parameters. The proposed approach simply uses standard statistical techniques to produce a full probability distribution for the WACC of an efficient benchmark firm in a manner that is entirely consistent with the parameter ranges that have been specified for the uncertain WACC parameters. This provides the regulator with a useful additional tool—the ability to explicitly measure the probability that a particular regulatory (allowed) WACC will be insufficient to meet the cost of funds of an efficient benchmark firm. This information will be useful to the regulator in setting an allowed return to balance (i) whether the costs paid by consumers are higher

than they need to be, with (ii) whether the returns earned are sufficient to ensure the viability of the regulated entity and provide the appropriate incentives for future investment. Clearly, a key piece of information to be considered by the regulator when assessing these competing objectives is the probability that the allowed WACC will be insufficient to meet the true cost of funds. This, of course, is directly related to the ongoing viability of the business and to the incentives for future investment. This non-recovery probability would be set at 50% if these two considerations were ranked equally. But they are not. Setting the non-recovery probability at 20-25% for example, would reflect the fact that it is more important to ensure the viability of the business than to ensure that customers pay the minimum possible cost.

The following section explores the appropriate probability of the regulated entity being unable to meet its cost of funds—what is an acceptable probability that the return allowed by the regulator threatens the viability of the business and future investment? Our conclusion on this point is that the regulatory WACC should be set so that there is a 75-80% chance that it will be sufficient to cover the true cost of funds of the benchmark entity. Figure 1 shows that a regulatory WACC set in the range of 7.8 – 7.9% would provide this level of confidence to the regulated businesses.

That is, given the uncertainty surrounding the estimates of key WACC parameters, and the interaction between parameters, a regulatory WACC of 7.8 – 7.9% would provide AGL Gas Networks with a return that is sufficiently likely to meet the cost of funds so as not to threaten the long-term viability of the business or to provide a disincentive for future investment.

Our estimate of the appropriate regulatory WACC is 80 - 90 basis points higher than that proposed by the tribunal in the Draft Determination. There are two reasons for this difference – different ranges have been used for some parameters (equity beta, debt margin and gamma), and use of the statistical approach to providing assurance about the likelihood that it will be sufficient to cover the entity's cost of funds. To separate these two effects, we perform our simulation analysis using the parameter ranges proposed by the Tribunal in the Draft Determination. We do, however, continue to use a normal distribution to model uncertainty in the estimate of MRP as this is well-grounded in statistics. This yields the parameter values and ranges that are summarised in the following table.

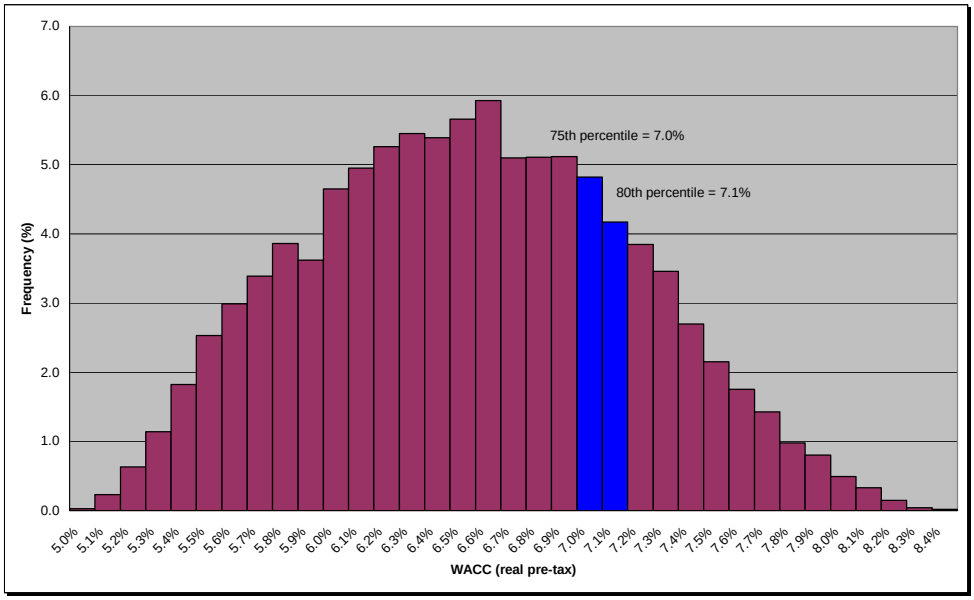
Table 2: IPART WACC parameter estimates from Draft Determination

Parameter	Symbol	Source	Estimate	Distribution
Real risk-free rate of interest	r_f	Yield on 10-year Government bond (20-day average).	2.8%	—
Capital structure	D/V	Comparables and regulatory decisions.	60%	—
Debt margin	—	BBB-BBB+ corporate bond yields.	1.15-1.25%	Uniform
Equity beta	β_e	Comparables and regulatory decisions.	0.8-1.0	Uniform
Market risk premium	*MRP*	Historical stock returns and 10-year govt. bond yields and regulatory decisions.	Mean=6%, Std Dev=1.8%[10]	Normal
Value of franking credits	γ	Empirical evidence and regulatory decisions.	0.3 – 0.5	Uniform

The results of our simulation analysis, using the parameter values and ranges in Figure 2

[10] Normal distribution with mean 6% and standard deviation 1.8%, consistent with historical variation in observed market risk premia.

Figure 2: Distribution of pre-tax real WACC estimates for 10,000 simulations – IPART parameter ranges



The result of this procedure is a mean WACC estimate of 6.5%, with standard deviation of 0.6%. The median WACC estimate is also 6.5%. The 90% confidence interval is between 5.5% and 7.6%. Our view is that the objectives of regulation are best achieved by setting the regulatory WACC so that there is a 75-80% chance that it will be sufficient to cover the true cost of funds of the benchmark entity. Figure 2 shows that if the Draft Decision parameters were correct, a regulatory WACC set in the range of 7.0 – 7.1% would provide this level of confidence to the regulated businesses.

For the reasons outlined above, however, we believe that there are strong reasons to use the parameter values and distributions that are specified in Table 1. This requires a regulatory WACC of 7.8 – 7.9% to provide a return that is sufficiently likely to meet the cost of funds so as not to threaten the long-term viability of the business or to provide a disincentive for future investment.

In the remainder of the paper, we explain why a regulatory WACC that provides the regulated business with a 75-80% chance of recovering its cost of funds is supported by empirical evidence and is consistent with the objectives of regulation.

3. The Probability that the Regulated Entity will earn a return that is sufficient to meet its cost of funds

Thus far, we have established that the regulatory WACC is an *estimate* of the entity's cost of funds. It is computed as the aggregation of a number of parameter estimates where some of these parameters are estimated with considerable estimation error. The entity's true cost of funds might be more or less than the regulator's estimate.

The Tribunal has also recognized this in the *2004 Electricity Distribution Pricing 2004/05 to 2008/09 (Final Report)*, p. 56, noting that the Tribunal "calculates a range for the weighted-average cost of capital (WACC). It then makes a judgement on what rate of return within this WACC range is appropriate, given the competing objectives in the Code. In particular, it aims to achieve an appropriate balance between the interests of customers and those of the DNSPs."

The Essential Services Commission also recognises estimation uncertainty in the *2003 Gas Distribution Review (Final Report)*, p. 313, "unlike the price for most goods and services, the market price for investment capital cannot be observed. Rather it needs to be *estimated* from information available from the capital markets. It is important to note that neither the company, the regulator nor customers can determine the cost of capital—it is a market price for investment funds that can only be inferred from the available evidence."

To assist the Tribunal to balance its competing objectives[11], we have illustrated a technique that produces a full probability distribution for the true cost of funds of an efficient benchmark entity. This probability distribution is entirely consistent with the uncertainty surrounding individual WACC parameter estimates. It also enables the Tribunal to compute the probability that a particular regulatory allowed WACC is insufficient to meet the cost of funds of an efficient benchmark entity. The likelihood of the regulator's determination providing a sufficient return on capital is central to the service provider's legitimate business interests and to the public interest in ensuring that the provision of key infrastructure remains a viable business and that the appropriate

incentives for future investment exist. Regulators under the National Gas Code are required to take all of these matters into account. Indeed it is difficult to see how the objectives of the Code can be met by a regulator that does not know the likelihood that the regulated WACC will cover the service provider's true cost of funds.

In this section, we propose that the regulatory WACC should be set so that there is at least a 75-80% chance that it is sufficient to meet the true cost of funds. This is based on the asymmetry in the consequences of erring on this matter. If the entity fails to earn a return that is at least equal to its cost of funds, there are implications for the ongoing viability of the entity and for future investment. These consequences can be severe, given that it is essential basic infrastructure business that are regulated. This regulatory risk must be balanced against the prices paid by consumers. There is a trade-off between price on the one hand and service and guaranteed supply on the other. Setting a 75-80% probability of being able to earn a return sufficient to cover the true cost of funds is consistent with the notion that ensuring the ongoing viability of the business and creating the right incentives for future investment is more important than keeping prices to a minimum, a view that is supported by the Productivity Commission. Note that if consumer prices and business viability are weighted equally, there is a 50% chance that the WACC will be insufficient to cover the entity's cost of funds.

Indeed, the Tribunal is required to exercise its judgment to achieve an appropriate balance between the interests of all stakeholders. The proposed approach provides a framework for quantifying exactly this trade-off—if prices (and returns) are to be lowered, how (quantitatively) will this impact the ability of the firm to meet its cost of funds and provide adequate returns to its investors?

Moreover, there are relatively long lead times for investment in gas distribution infrastructure. This reinforces the argument in favour of allowing regulated distribution business a better than even chance of earning their cost of funds. If the regulatory WACC is set too low, there is a significant chance that the firm will be unable to recover its cost of funds. In practice, firms invest only when there is a relatively high probability

[11] For example, the National Gas Code (Sec 2.24) requires the relevant regulator to take into account "the Service Provider's legitimate business interests and investment in the Pipeline," "the economically efficient operation of the Covered Pipeline," and "the public interest, including the public interest in having competition in markets (whether or not in Australia)"

of the investment earning a return that exceeds the cost of funds. Much of the evidence of this is reviewed below. Thus, a low regulatory WACC provides a disincentive for future investment. In addition, realized returns in the current period can be increased (perhaps enough to cover the cost of funds) by underspending against scheduled CAPEX. In both cases, the result is underinvestment in gas distribution infrastructure. Of course, this can be corrected in future periods if the regulatory WACC is increased, realised returns are increased, or by external injection of funds (e.g., as proposed by the Queensland Government to remedy this very issue in relation to the ENERGEX and Ergon electricity distribution businesses). The problem with this approach, of course, is that there are significant lead times involved. The Queensland electricity distribution businesses, for example, are currently having difficulty obtaining the required infrastructure and skill base to implement a significant increase in CAPEX spending. The result is that the electricity distribution network is likely to experience problems for some years. These factors are particularly relevant to the principles of "providing the Service Provider with the opportunity to earn a stream of revenue that recovers the efficient costs of delivering the Reference Service," "replicating the outcome of a competitive market," and "providing an incentive to the Service Provider[12]".

Conversely, the regulatory WACC may be set so that there is a better than even chance of the entity recovering its cost of funds. Some would argue that in this case there is an incentive for firms to over-invest in CAPEX. However this is a much less severe problem for two reasons. First, the regulator approves prudent CAPEX. Any overspend will not (initially at least) generate any return on capital for the firm. Contrasted with this is the fact that any CAPEX underspend is retained by the firm as cash. Second, any CAPEX spending that really is beyond requirements is not simply waste. With a growing demand for energy, this additional CAPEX would eventually be required. That is, the issue is simply one of timing—was the CAPEX really required today, or could it have waited for a year or two? Thus, the effects of CAPEX overspending are minor, relative to CAPEX underspending. In one case, investment earns a return for a year or two longer than it should have. In the other case, underspending causes bottleneck and other problems from lack of sufficient infrastructure and a shortfall of energy supplies. The aggregate welfare effects are much more severe in this case.

[12] National Gas Code, Section 8.1.

This issue has recently been addressed in some detail by the Productivity Commission (PC), the Supreme Court of Western Australia and the Australian Competition Tribunal. For example, the Productivity Commission's Review of the National Access Regime recognises that the effects of too little infrastructure investment are far more severe than those associated with too much (or too early) investment. The PC states (p. xxii) that "Given that precision is not possible, access arrangements should encourage regulators to lean more towards facilitating investment than short term consumption of services when setting terms and conditions" and that "given the asymmetry in the costs of under- and over-compensation of facility owners, together with the informational uncertainties facing regulators, there is a strong in principle case to 'err' on the side of investors".

The PC goes on to quote from a submission to the review by NECG, which stated that "In using their discretion, regulators effectively face a choice between (i) erring on the side of lower access prices and seeking to ensure they remove any potential for monopoly rents and the consequent allocative inefficiencies from the system; or (ii) allowing higher access prices so as to ensure that sufficient incentives for efficient investment are retained, with the consequent productive and dynamic efficiencies such investment engenders. There are strong economic reasons in many regulated industries to place particular emphasis on ensuring the incentives are maintained for efficient investment and for continued productivity increases. The dynamic and productive efficiency costs associated with distorted incentives and with slower growth in productivity are almost always likely to outweigh any allocative efficiency losses associated with above-cost pricing. (sub. 39, p. 16)"

The PC Review highlighted the need to modify implementation of the regime and made 33 recommendations to improve its operation. In particular it identified as a "threshold issue, the need for the application of the regime to give proper regard to investment issues" and "the need to provide appropriate incentives for investment."

This view is supported by the Commonwealth Government, which has resolved to amend the Trade Practices Act in this regard. In particular, the access regime will be modified to include a clear objects clause: "The objective of this part is to promote the economically efficient operation and use of, and investment in, essential infrastructure

services thereby promoting effective competition in upstream and downstream markets…"

In addition, a set of pricing principles will be included that requires "that regulated access prices should: (i) be set so as to generate expected revenue for a regulated service or services that is at least sufficient to meet the efficient costs of providing access to the regulated service or services; and (ii) include a return on investment commensurate with the regulatory and commercial risks involved…"

We argue that these views are consistent with the notion that the regulatory WACC should be set so that there is a better than even chance of the entity recovering its cost of funds.

In the remainder of this section, we examine commercial practice in this regard. In particular, we examine whether firms make investment decisions based on an estimate of WACC, or whether they use a hurdle rate that exceeds the estimated WACC to ensure that there is a better than even chance of the investment producing a return above the cost of funds and therefore creating shareholder value.

Many studies have investigated the relationship between companies' cost of capital and the hurdle rate they use in investment decisions. Generally, these studies have found that the hurdle rates used are significantly above the firm's cost of capital: on average, at least 5 percent higher. This finding is now well established within the literature, and more recent research has attempted to investigate the reasons for this. The discussion below reviews studies that investigate the difference between hurdle rates and cost of capital, their methodologies and findings, and where relevant, any proposed explanation for the phenomenon.

3.1. Summers (1987)

The most widely cited study examining hurdle rates is that of Summers (1987). The purpose of his study was twofold. First, to establish the theoretical discount rate that should be used to discount depreciation allowances. Second, to compare this rate to the actual discount rate being used by managers in the largest firms in the US.

In the first section of the paper, Summers argues that in the context of an investment project, the tax deductions relating to depreciation should be discounted separately from the operating cash flows of the project, as the depreciation deduction will essentially be risk-free, whereas the cash flows from the project will generally be risky. Consequently, the rate that should be used to discount tax depreciation is the yield on Treasuries, which at the time of the study was about 8-9 percent. Given a corporate tax rate at the time of 46 percent, Summers concluded that a nominal rate of less than 5 percent was appropriate as a discount rate. Based on the inflation rate at the time, the real discount rate implied was close to zero.

The author then surveyed the Chief Financial Officers of the top 200 Fortune 500 companies in the U.S. (obtaining 95 useable responses), in order to investigate companies' actual capital budgeting policies. More specifically, the questionnaire asked the managers to report hurdle rates for an average project, and whether different discount rates were used for projects with different risk profiles. The most common response received was that the same rate was used to discount all cash flows from a particular project. The hurdle rates employed ranged between 8 and 30 percent, with a mean of 17 percent.

While Summers did not directly compare the hurdle rates observed with cost of capital (as the study focused on the discount rate for depreciation tax deductions), his results can be compared with two studies around the same time which looked at companies' theoretical cost of capital. Kaplan (1986) argued that the real cost of capital for an average business was around 8 percent. Samuels and Wilkes (1986) suggested that the real discount rate should be 7 percent. Therefore, even assuming a long term inflation rate of between 4 and 5 percent, which is probably too high, it could be concluded on the basis of Summers' study that the hurdle rates used are 4 to 5 percent higher than the firm's cost of capital. This finding is consistent with a later study carried out by Poterba and Summers (1995), which is described below.

3.2. Poterba and Summers (1995)

A second important U.S. study conducted in this area was that done by Poterba and Summers (1995). The purpose of their paper was to determine if a difference existed

between hurdle rates and capital costs, and examine the implications of any difference in terms of the investment horizons of U.S. firms.

The authors sent a survey of questions relating to capital budgeting and investment decisions to the CEOs of Fortune 1,000 companies in the U.S., and received 228 useable responses. The most relevant question asked in the survey, in terms of this review, was one which asked respondents to report the hurdle rate that they would employ to discount cash flows on a typical project in the firm's largest division. Most of the responses were in the form of nominal rates, which the authors converted to real rates using an expected long-term inflation rate of 5 percent. This yielded a real hurdle rate of 12.2 percent for the entire sample, and slightly lower (11.6 percent) for manufacturing firms only. They compared this figure to average realized real returns on debt and equity since the 1920's, and found them to be significantly lower, at about 2 and 7 percent respectively. Therefore, even if firms were assumed to be 100 percent equity financed, which of course is unrealistic, the hurdle rate employed will still be 5 percent higher than the firm's cost of capital.

The authors did not explore the reasons for the difference between hurdle rates and cost of capital in any great detail. They suggested, in passing, that it may be due to overly optimistic cash flow forecasts on possible projects.

3.3. Other U.S. and U.K. Survey Evidence

There have been many other surveys conducted in relation to hurdle rates in both the US and the UK. In terms of techniques used to evaluate investment opportunities, Kennedy and Sudgeon (1986) surveyed firms in both the U.S. and U.K. and found that the most common method of project evaluation used in firms within the sample was to add a premium to the cost of capital.

A significant number of other studies have attempted to quantify the hurdle rates used by firms, in a similar manner to Summers (1987) and Poterba and Summers (1995). The most significant U.K. study carried out in this area was done by the Confederation of British Industry (CBI) and the Association of Consulting Actuaries' (ACA). The organizations surveyed 326 of the largest listed companies in the U.K. This research found that the average hurdle rate being used by firm's was 17.1 percent, whereas the

cost of capital was around 11.9 percent. Waites (1998), in interpreting these survey results, argued that the high hurdle rates could be linked to a generalized allowance for risk.

Scapens and Sale (1981) surveyed 300 Times 1.000 companies in the U.K. and 227 Fortune 500 companies in the US. From these surveys, they concluded that the average hurdle rates being employed in the U.K. and U.S. were 18.5 and 17.1 percent respectively, with some companies reporting hurdle rates up to 40 percent. Woods et al (1985) found an average hurdle rate of 23.7 percent, and Fotsch (1983) reported an average rate of 25 percent. If these results are compared to the cost of capital figures reported by Kaplan (1986) and Samuels and Wilkes (1986) of 8 and 7 percent, the hurdle rates are again found to be significantly higher: of the order of at least 5 percent[13].

3.4. Diederen, Van Tongeren and Van der Veen (2003)

Diederen et al used a different methodology to investigate the differences between company hurdle rates and actual cost of capital. The study began by making an observation in relation to the adoption of two new technologies: they stated that whilst these technologies should be adopted by more than 90 percent of firms in the industry on the basis of NPV calculations, the adoption rate was much lower (49% for one of the technological improvements, and 79% for the other).

The authors then attempted to predict the hurdle rate used by firms. Their predicted hurdle rate was, on average, 1.76 times the ordinary cost of capital. The study found that this model had significant power in terms of explaining the decision to invest of firms in the sample. They suggested that the reason for the discrepancy was the uncertainty in future energy prices, which they incorporated into their model.

3.5. Other Explanations for the Discrepancy

A variety of studies have put forward other suggestions for observed high hurdle rates such as the value of an option to wait to invest (Purvis et al 1995 and Diederen et al 2003); overcoming managerial incentives to over-invest (Antle and Eppen 1985 and Antle and Fellingham 1990); market imperfections (DeCanio 1998); high transaction

costs in relation to adopting new technology (Fagundes de Almeida 1998) and uncertainty about future technological developments (Grenadier and Weiss 1997). This indicates that there is no single specific reason for the use of high hurdle rates, but that some form of uncertainty is central to any explanation.

3.6. Summary

The literature reviewed above illustrates two key points. First, there is considerable evidence to show that companies in both the U.S. and U.K. use hurdle rates that substantially exceed their cost of capital in order to evaluate potential investment opportunities. Second, the reason for the observed discrepancy between hurdle rates and cost of capital has not been resolved, but uncertainty is a key element of any explanation.

This result is consistent with firms developing corporate investment policies to ensure that an investment will only proceed if there is a significantly higher than 50/50 chance that the investment will earn a return in excess of the cost of funds. The implication in this context is that a regulatory WACC set such that there is a 50/50 chance of it being high enough to cover the entity's true cost of funds is inconsistent with corporate practice and insufficient to attract the required levels of new investment.

Finally, the magnitude of the difference between corporate cost of capital and estimated WACC suggests that firms are reluctant to invest unless there is a better than 75-80% chance that the investment will generate a return in excess of its cost of capital. In fact, this magnitude suggests that firms are unlikely to invest unless the investment is highly likely to generate a return in excess of the cost of funds. In this respect, setting this probability at 75-80% appears to be conservative.

We conclude that it is appropriate for the Tribunal to set the post-tax real vanilla WACC in the range of 7.8 - 7.9%.

[13] That is, once the hurdle rates have been adjusted for inflation.

4. Asymmetric risk

Finally, we note that this report does not address asymmetric risks or extraordinary events—non-systematic risk of a significant loss. These asymmetric risks require an adjustment to the cash flows or the discount rate. That is, the proposed WACC will imply certain price or revenue targets which must be adjusted to account for asymmetric risk. Alternatively, for pragmatic reasons the regulated business and regulator may favour an increase to the regulated WACC to compensate for asymmetric risk. Neither of these adjustments is specifically addressed in this report.

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The Value of Imputation Franking Credits: Gamma

Report for AGL in Relation to ESC Electricity Distribution Review

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CONTENTS

1. THE VALUE OF IMPUTATION FRANKING CREDITS: GAMMA

The value of imputation franking credits, gamma, can be defined as the proportion of actual company tax paid on behalf of the marginal price-setting investor which is really a pre-collection of personal tax. Australian regulators have almost uniformly adopted an estimate of 0.5 for gamma. In particular, The Commission has used this estimate in both their Final Determination and Final Decision for Victorian Electricity and Gas businesses respectively (Office of the Regulator-General: Victoria Electricity Distribution Price Determination, 2001-2005; and Essential Services Commission Review of Gas Access Arrangements: Final Decision, October 2002).

The Commission has made a number of arguments to support setting $\gamma = 0.5$. These arguments can be broadly summarized as follows:

1. The empirical evidence is mixed and there is no reason to place more weight on one paper than any other.

2. The value of franking credits should be based on the value to the average investor in Australia. Some comments by The Commission indicate that this should be read so as to ignore foreign investment entirely. However, The Commission's most recent view appears to be that this should be interpreted as the average of the values placed on franking credits by investors in the Australian market.

3. Shareholder returns are reduced to the extent that franking credits are assumed to have value. This acts to the disadvantage of foreign investors who do not benefit from franking credits. However, foreign investors receive other advantages in the form of diversification benefits to compensate them for any mis-estimation in the valuation of franking credits. That is, the mis-estimation of gamma (which disadvantages foreign investors) is offset by the mis-estimation of beta.

In this paper, we analyze the arguments that have been made by The Commission, together with the relevant academic and practitioner literature. We develop a framework for considering a whole range of arguments in a consistent manner. In particular, we highlight which arguments are consistent with the techniques used to estimate other WACC parameters and which are not.

We also examine new evidence on this question. Since The Commission's last regulatory determination, two important additional pieces of market-based empirical evidence on the value of franking credits have become available.

First, one of the world's leading finance journals, the *Journal of Financial Economics*, has published a paper which suggests that for large Australian companies with significant foreign ownership, franking credits are effectively worthless to the marginal price-setting investor, at least since the introduction of the 45-day holding period rule made it more difficult to transfer these credits. This evidence in the

leading international peer-reviewed journal must be contrasted against un-reviewed, unpublished working papers and local publications.

Second, there is additional empirical evidence which suggests that the studies that Australian regulators have relied on in arriving at its estimate of 0.5 for gamma, should more appropriately be interpreted as providing strong support for the notion that gamma is equal to zero. When properly accounting for the statistical problem of multicollinearity, the evidence on which most Australian regulators have relied is entirely consistent with the proposition that franking credits are not valued by the marginal price setting investor.

Since The Commission's last determination, there is no additional evidence to support the notion that franking credits have a positive value.

In light of the totality of the conceptual arguments and the most recently available empirical evidence, the most appropriate estimate of gamma is zero. At the very least, it is impossible to reject the notion that $\gamma = 0$.

2. OVERVIEW OF ARGUMENTS

In this section, we summarize and logically arrange the arguments that have been made in relation to the estimation of the value of franking credits. These arguments are briefly summarized in Figure 1. This section provides an overview of Figure 1 and demonstrates how the various arguments fit together. The balance of this paper then examines each argument in turn in more detail.

Before turning to specific arguments about the value of franking credits, it is useful to provide some context to establish why this issue is important in the first place. In the Australian regulatory setting, the regulator is required to compute the weighted-average cost of capital (WACC) of an efficiently managed firm of the type that is being regulated. This WACC forms the basis of the return on capital that is part of the regulated firm's revenue requirement.

The relevant legislation is quite clear about what the WACC is, how it should be interpreted, and even how it should be measured. For example, the National Electricity Code states that a central part of the regulatory framework is "setting target rates of return for Government enterprises on the basis of the marginal rate of return of private sector investments of similar risk[1]". The Code goes on to define WACC as a, "forward looking" cost of capital that represents the shadow price or opportunity cost of capital as measured by the rate of return required by investors in a privately-owned company with a risk profile similar to that of the network company[2]".

The legislation refers to WACC as a forward-looking opportunity cost of capital. This means that potential investors will consider the future return that they are likely to receive from comparable investments. They will only be prepared to supply investment capital to a firm if the return they expect to receive from that firm is at least equal to the return they would expect to receive from a comparable investment. It is for this reason that Australian regulatory legislation requires regulators to examine "any relevant interstate and international benchmarks for prices, costs and return on assets in comparable industries[3]".

Of course, there is a difference between the return required by investors and the firm's cost of capital. This is because some of the return that is required by investors may actually be paid by government via the tax system. Suppose, for example, that debt investors require a return of 7% because that is the return they could receive from a comparable investment—that is their opportunity cost. If the relevant corporate tax rate is 30% the firm pays the debt holders their 7% return, but then receives a tax deduction that is worth 30% x 7% = 2.1%. In this case, the firm has

[1] National Electricity Code, Schedule 6.1 (1).

[2] National Electricity Code, Schedule 6.1(2.1).

[3] Essential Services Commission Act 2001, 5.33(3)(e).

contributed (net) 4.9% and the government has funded the other 2.1% via the tax system. Investors are satisfied because they receive the 7% required return. The firm's cost of debt capital in this case is 4.9%.

Of course this point is well recognized in the academic and practitioner literature. Copeland, Koller and Murrin (2000) for example note that WACC is "the opportunity cost to all the capital providers weighted by their relative contribution to the company's total capital" (p. 134). They also note that, "the opportunity cost to a class of investors equals the rate of return the investors could expect to earn on other investments of equivalent risk. The cost to the company equals the investors' costs less any tax benefits received by the company (for example, the tax shield provided by interest expense)" (p. 134-5).

In a dividend imputation system, the government may also subsidize equity returns via the payment of franking tax credits. If an investor's required return on equity capital is 12%, the corporate tax rate is 30% and $\gamma = 0.5$ (as most Australian regulators assume), the investor will receive franking credits sufficient to provide a return of around 2%, leaving the firm to provide the other 10% of the investor's required return.

The difficulty arises in the sense that domestic investors benefit from franking credits, but foreign investors do not. As with any price, the firm's cost of capital is determined at the point where demand equals supply. The price that the firm must pay to attract the last dollar of capital determines its WACC. If the firm is able to attract sufficient equity capital by offering to pay 10% (as investors receive the other 2% via franking credits) then its cost of equity capital is 10%. If the firm must pay 12% because it requires foreign capital, then its cost of equity capital is 12%. The firm's cost of equity depends on the price at which supply equals demand and the market clears.

Before turning to Figure 1, we develop some principles that a regulator should follow in traversing this argument. These principles form the basis for "reasonable regulatory accountability through transparency and public disclosure of regulatory process and the basis of regulatory decisions[4]".

2.1. PRINCIPLE 1: ESTIMATE WACC INDEPENDENTLY

The regulator should estimate WACC without regard to politically acceptable outcomes or the interests of consumers and network users. Of course, the regulator must balance all of these considerations, but this should not be done by mis-estimating WACC parameters. WACC should be estimated first as a measure of the interests of the regulated business. This should then be balanced against competing interests. That is, a regulator may determine that considerations such as social impact, the ability of consumers to pay, or the political impact of the decision must be balanced against the return on capital required by investors in the regulated business. If this is the case, it should be stated as such. The only way such a balancing of interests can be achieved is if the assessment of the required return is not influenced by competing objectives. That is, the return must

[4] National Electricity Code, 6.10.2(j).

be estimated and then balanced against competing objectives, not the other way around. That is, a regulator should not re-construct the WACC by choosing parameter estimates to support a WACC that is consistent with a pre-determined pricing outcome.

2.2. PRINCIPLE 2: TRANSPARENCY AND CONSISTENCY

The regulator should choose an asset pricing model and state its choice. If a regulator refers to more than one asset pricing model, there should be an opportunity for all stakeholders to comment on all parameters of all models. Untested estimates from alternative models that have not been peer-reviewed should not be discussed in a regulatory decision.

2.3. PRINCIPLE 3: OBTAIN THE BEST ESTIMATE OF EVERY PARAMETER

The regulator should obtain the best available estimate of every parameter. It is not appropriate to justify the mis-estimation of one parameter by stating that other parameter estimates have equal and opposite errors.

2.4. PRINCIPLE 4: USE MARKET DATA, HAVING REGARD TO QUALITY

Parameter estimates should be based on the best available market data where possible, and should not be assumed. Regard must be paid to the quality and statistical reliability of the available market data.

2.5. PRINCIPLE 5: WACC IS THE MARKET CLEARING PRICE OF CAPITAL

Parameters should be estimated in a way that is consistent with the WACC being a forward-looking opportunity cost of capital. WACC should be interpreted as the price of capital—the price that equates supply and demand and thus clears the market.

With these principles in mind, we now turn to a discussion of the outline of arguments on the value of franking credits in Figure 1.

2.6. DISCUSSION OF ARGUMENTS RELATING TO THE VALUE OF FRANKING CREDITS

The first question to be addressed is:

2.6.1. SHOULD AUSTRALIAN CAPITAL MARKETS BE ASSUMED TO BE INTEGRATED WITH, OR COMPLETELY SEGMENTED FROM, GLOBAL CAPITAL MARKETS?

This question is the starting point due to the potential importance of foreign investors on the value of franking credits. Clearly, there is overwhelming and obvious evidence of Australia's integration into global capital markets. Constraints on cross-border capital flows are minimal. Importantly, 30-40% of Australian equities are owned by non-residents. However, some have argued that in spite of this evidence we should *assume* that Australian capital markets are perfectly segmented from the rest of the world. For example, Lally (2002) argues that perfect segmentation should be assumed in order to preserve consistency with the domestic version of the CAPM that is employed by Australian regulators. That is, the model assumes segmentation, so we must measure all parameters in a way that is consistent with this assumption. This requires us to reject the available empirical evidence on the value of franking credits as this evidence is contaminated by foreigners. We should, instead, estimate γ as it would be if Australia were perfectly segmented. However, if this were done, we must also estimate the risk-free rate, market risk premium, and beta not as they are, but as they would be in the absence of foreign investment. For example, the risk-free rate would likely be significantly higher if the supply of debt capital were reduced by removing all foreign investment. Clearly, re-estimating all WACC parameters as they would be in the absence of foreign investment is an impossible task and this approach must be rejected. That is, all WACC parameters should be estimated as they are, not as they would be if a particular theoretical assumption were to hold. This leads Lally (2002) to suggest that the alternative to a theoretically pure domestic CAPM is a version of the international CAPM. We provide a more detailed response to Lally (2002) in section 3 of this report.

2.6.2. SHOULD WE USE THE DOMESTIC OR INTERNATIONAL CAPM?

The international CAPM has the advantage that it specifically allows for foreign investors. However, there are many versions of international CAPM. This would result in significant debate about which version of the models should be used and how all of the additional parameters should be estimated. This would dramatically increase regulatory expense and uncertainty for all stakeholders. Moreover the international CAPM is not used in practice and produces results that do not differ significantly from the domestic CAPM anyway. For these reasons, use of the standard domestic CAPM with parameters estimated as they are, should be the preferred approach.

2.6.3. SHOULD WE USE MARKET EVIDENCE OR CONCEPTUAL ARGUMENTS TO ESTIMATE WACC PARAMETERS?

We have already argued above that all WACC parameters should be estimated as they are, not as they would be if a particular theoretical assumption were to hold. The issue here however, is subtly different. The value of franking credits can be inferred from the market prices of traded securities or it can be inferred by conceptualizing a particular type of investor and considering how they would value franking credits. Market prices tell us something about how the market values franking credits and is therefore directly relevant to the estimation of WACC. The value of franking credits to a particular type of investor is only relevant if that investor clears the market. Thus, market data

should always be used, where available. Although direct evidence may not be available, the best market data that does exist should always be preferred to conceptual assumptions. For completeness, however, we continue to examine the use of a conceptual investor type.

2.6.4. SHOULD THE VALUE OF FRANKING CREDITS BE BASED ON THE CONCEPT OF THE AVERAGE INVESTOR OR THE MARGINAL PRICE-SETTING INVESTOR?

First, note that all other WACC parameters are based on the marginal price-setting investor's valuation. Risk-free rates, for example, are set initially by the auction of government bonds to potential investors and then by trade between investors. Some investors value government bonds highly and are prepared to bid a high price. Others bid moderate or low prices. Most investors do not bid at all and hold no government bonds. In such an auction, the price is set by the marginal investor—the investor who buys the last bond, thus clearing the market. This investor's valuation will be recorded as the market price and will determine the risk-free rate at that time. All investors with a higher valuation will also receive bonds, but their valuations are irrelevant to the market-clearing price. All that matters is that they had a higher valuation—how much higher makes no difference to the equilibrium outcome price. Similarly, the value of government bonds to unsuccessful bidders and to non-bidders is also irrelevant to the price. The price that we observe in the market is the valuation of the marginal, price-setting, market-clearing investor. To compute the value of government bonds to the average investor, we would need to know how much *every* investor valued government bonds and then take an average. This would presumably require survey data, because it cannot be inferred from market prices. This would not only be difficult, but also irrelevant as it has nothing to do with the firm's cost of funds which depends on actual market prices, which are set by the marginal investor's valuation.

If the appropriate benchmark investor is the marginal price-setting investor who determines the price the firm must pay for funds, then market prices are the appropriate source of data. We shall examine this subsequently, after continuing to discuss the conceptual average investor.

2.6.5. SHOULD WE CONSIDER THE AVERAGE INVESTOR IN THE AUSTRALIAN MARKET OR THE AVERAGE INVESTOR IN AN EFFICIENT BENCHMARK FIRM?

If the notion that traded prices represent market-clearing conditions that balance demand and supply is rejected, then WACC parameters must be considered in the context of a conceptual benchmark investor. In this case, a question arises as to whether the appropriate benchmark is the average investor in the Australian market, or the average investor in an efficient benchmark firm. The problem with valuing franking credits by averaging over all investors in the Australian market is that all other parameters are estimated with reference to an efficient benchmark firm. Betas and leverage, for example, are estimated with reference to comparable firms. If these parameters were estimated over the entire Australian market, beta would be one and leverage would likely be considerably lower than current estimates. For consistency, these parameters must all be estimated with reference to an efficient benchmark firm, not averaged over the entire market.

But even if franking credits are estimated in the context of an efficient benchmark firm, the average value across investors is still inappropriate as all other WACC parameters are based on market prices. These market prices are the equilibrium outcome of trading that clears the market and determines

what the firm must offer in order to attract funds. To be consistent with the way all other parameters are estimated, we must use market data to estimate the value of franking credits.

2.6.6. SHOULD WE USE TRADED SECURITY PRICES OR DIVIDEND DROP-OFFS TO ESTIMATE THE VALUE OF FRANKING CREDITS?

Two main types of market data have been used to infer the value of franking credits: (i) the simultaneous prices of securities that do, and do not, entitle the holder to dividends and franking credits, and (ii) the amount by which stock prices change on ex-dividend days (dividend drop-offs).

Two unpublished working papers have been used by Australian regulators to support their use of $\gamma = 0.5$. New evidence using the same data and methodology, but more robust statistical methods demonstrates that it is impossible to reject the hypothesis that $\gamma = 0$. That is, there are statistical problems with the most influential evidence on which The Commission has relied in the past. When this is corrected, there is support for the view that $\gamma = 0$.

If this data and methodology is rejected, there are two broad classes of traded security prices that can be used, as explained below.

2.6.7. SHOULD WE USE FUTURES PRICES OR OTHER DATA TO INFER THE VALUE OF FRANKING CREDITS?

Cannavan, Finn and Gray (2004) has been published in the leading *Journal of Financial Economics*. It is based on a large number of observations from large Australian firms that require foreign capital—similar to benchmark infrastructure companies. That is, the sample is not representative of *all* Australian firms but it is representative of the kind of firm that is regulated, which makes it more directly relevant.

By contrast, the couple of papers in local journals examine a few rights issues or cum-dividend trading, are based on few observations and few firms (mainly banks). Also, these markets are designed primarily to transfer franking credits between investors and therefore are not representative of the value of franking credits to long-term providers of capital.

2.7. CONCLUSION

The conclusion from all of this analysis is that we should use market data to estimate the value of franking credits as they are valued by the market. The best such data, whether futures and stock prices or dividend drop-offs, suggests that $\gamma = 0$. Placing a zero value on franking credits is also consistent with market practice. In the balance of this paper, we further examine the evidence on the value of franking credits in light of the framework that appears in Figure 1.

3. CONSISTENCY WITH ASSET PRICING MODELS

In Australia, commercial and regulatory practice is to use the standard domestic CAPM to estimate a firm's cost of equity capital. This standard CAPM is implemented by using parameter estimates based on domestic Australian data. The risk-free rate is estimated as the yield on Australian government bonds. The market risk premium is estimated by observing historical Australian stock and bond returns. The equity beta is interpreted as a measure of the relationship between the returns on the firm's equity with the returns on a broad index of Australian stocks.

The mathematical derivation of the CAPM assumes that all investors can borrow and lend as much as they like at the risk-free rate and that all investors hold the risk-free asset and the market portfolio of risky assets, in some proportion.

The theoretical implications of the CAPM and the standard implementation of that asset pricing model can only be reconciled by considering the Australian domestic economy to be *the* market. This is because (i) the CAPM implies that *all* investors face the same risk-free rate and the same market portfolio; and (ii) the standard implementation of the CAPM is based on a domestic Australian risk-free rate and a domestic Australian market portfolio.

This implies that theoretical consistency between (i) the standard CAPM (which is used as the asset pricing model that forms the basis for the calculation of the cost of equity capital) and (ii) the way the CAPM is implemented in practice and by regulators requires the additional assumption that Australia is perfectly segregated from the world economy. That is, Australia must be considered to be *the* market and all investors in the CAPM must be assumed to be domestic Australian investors. All forms of foreign investment and cross-border capital flow must be explicitly ignored. Even though there is clear and obvious evidence of significant foreign investment in Australia, this must be ignored if theoretical consistency with the domestic CAPM is to be preserved.

This has led some authors to suggest that theoretical consistency with the standard CAPM requires that we rule out any effect that non-resident investors may have on the value of franking credits. That is, even though we know that significant amounts of franking credits are paid to non-residents who cannot redeem them, some would suggest that we ignore this because non-resident investors cannot theoretically exist within the standard CAPM as it is commonly implemented.

For example, Lally (2002) concludes (pp. 3-4) that, "use of a version of the Capital Asset Pricing Model that assumes that national equity markets are segmented rather than integrated is recommended. It follows that foreign investors must be completely disregarded. Consistent with the disregarding of foreign investors, most investors recognized by the model would then be able to fully utilize imputation credits".

It should be noted that the Ralph reforms occurred subsequent to the writing of this paper. Now, even tax-exempt domestic investors benefit (via a rebate) from receiving franking credits. Presumably not "most", but "all" investors recognized by the model would fully value franking credits now, although this is irrelevant unless these investors clear the market (which is very unlikely).

Lally (2002) continues (p. 4) to note that, "the product of the utilization rate and the ratio of imputation credits assigned to company tax paid (denoted gamma by the ACCC) should be at or close to 1 for most companies rather than the currently employed figure of 0.50. The effect of this change would be to reduce the allowed output prices of regulated firms."

This conclusion follows from the fact that all non-resident investment is ignored. That is, gamma should be set close to one based on theoretical assumption, despite clear empirical evidence to the contrary. This is made subsequently clearer (p. 34), "the principal holders of Australian equities are foreigners, companies, superannuation funds and individuals…on account of assuming that national capital markets are segregated, recognition of foreign investors is both inconsistent and leads to perverse results. Accordingly they are omitted from consideration."

That is, there is clear contrast between the empirical reality of non-resident investment and the theoretical assumption in which they are "omitted from consideration."

The Commission, who cite this work by Lally quite extensively, also notes that theoretical consistency would require that foreign investors are omitted from consideration (*2002 Gas Distribution Review (Draft Report) p. 258; 2001 Electricity Distribution Review (Draft Report) p. 188-9).*

There are at least two reasons to reject the argument that preserving the theoretical consistency of an imperfect model should be preferred to recognizing the empirical evidence of non-resident investment. That is, there are two reasons why we should try to estimate gamma as it is, rather than as it would be if non-resident investment did not exist.

Reason #1: The standard CAPM has many other theoretical problems, but is still the industry standard in practice. Many of the CAPM's assumptions are not supported in practice.

It is clear that not all investors can borrow and lend unlimited amounts at the risk-free rate. Should we omit from consideration all investors who cannot borrow and lend at the same rate as the government?

It is clear that not all investors hold the market portfolio. Should we omit from consideration all investors who own anything but index funds?

The CAPM is a one-period model. Should we omit from consideration all investors who consider reinvestment risk?

If investors who violate these assumptions remain in consideration, why not continue to consider non-resident investors?

Moreover, if non-residents are to be omitted from consideration in regard to franking credits, they should also be omitted from consideration in regard to other WACC parameters. This requires that the asset beta, risk-free rate, and market risk premium be recomputed to reflect the values they would take in the absence of foreign investment. It is likely that the supply of foreign capital has reduced the risk-free rate and market risk premium, but any quantification of this effect is clearly difficult. In any event, as explained below, this is probably unnecessary.

The key point here is that the CAPM, and all asset-pricing models, are merely tools to help approximate very complex equilibrium outcomes. No such model will be perfect. The standard CAPM is the most widely used asset pricing model in commercial practice. Graham and Harvey (2001), for example, report that three quarters of U.S. Fortune 500 CFO's always, or almost always, use the standard CAPM to compute cost of equity capital. Why does this model have such widespread acceptance in practice? Not because of the reality of its assumptions, but because it is implementable and it serves the purpose. Moreover, it is clear that when implementing the CAPM, parameters are estimated as they are, not as they would be if all investors who violated any theoretical assumption did not exist.

Reason #2: The domestic CAPM serves as a close approximation of an international CAPM anyway.

Lally (2002) notes that if non-resident investors are to be considered, it is theoretically inconsistent to use the standard domestic CAPM. He argues that theoretical consistency requires the use of an international version of the CAPM. He conjectures that within such an international CAPM, beta estimates and the market risk premium may be lower than in the domestic CAPM. He rejects the use of such an international CAPM on the basis of (i) the additional complexity of the model and parameter estimates required, (ii) the problem of choosing one specification among a long list of proposed international CAPM's; and (iii) lack of evidence of performance superior to the domestic CAPM.

Subsequent to Lally (2002), Koedijk, Kool, Schotman and van Dijk (2002) and Koedijk and van Dijk (2004) have examined cost of equity estimates from international and domestic CAPM's. In particular, they test whether the cost of equity computed in the standard manner using the domestic CAPM differs from that computed using the international CAPM models.

For their sample of over 100 Australian firms, they conclude that the domestic and international CAPM's produce significantly different estimates of the cost of equity for less than 5% of firms. The rates are comparable for eight other developed markets that were examined.

That is, standard implementation of the domestic CAPM produces estimates of the cost of equity that are not significantly different from estimates produced by a more complex international CAPM. If non-resident investors do exist, theoretical consistency requires the use of an international CAPM.

However, this dramatically increases the complexity, and cost of regulation, and produces results that are not significantly different from the domestic CAPM anyway.

Thus, if theoretical inconsistency between the existence of non-resident investors and the use of a domestic CAPM is a problem, the domestic CAPM can simply be considered as a close approximation of the results that would be produced by a more complex international CAPM.

For these reasons, it is recommended that The Commission continue to use the standard domestic CAPM, consistent with industry and regulatory practice.

4. USING AGGREGATE TAXATION STATISTICS

In previous determinations, The Commission has (implicitly) argued that the value of gamma used in pricing determinations should be based on a market wide estimate derived by reference to the average Australian investor. In the *2003 Gas Distribution Review (Draft Report)*, for example, The Commission (p. 261) proposes to estimate gamma as the product of the average proportion of franking credits that are distributed to shareholders and the average utilization rate of franking credits that are distributed. The Commission employs estimates of these quantities from Hathaway and Officer (1996). The estimates used by The Commission are averages across all firms and all shareholders – they are based on aggregate tax statistics. Moreover, the Commission summarises the results from several other papers on this point. All of these papers produce an estimate of the value of distributed franking credits that differs from that of Hathaway and Officer (1996). Yet The Commission uses the exact estimates of Hathaway and Officer in its estimation of gamma.

We raise three issues in relation to this approach.

4.1. MARKET-WIDE AVERAGES ARE MEANINGLESS

Using aggregate tax statistics implies that an important cost of capital parameter should be determined without any reference to the nature of the type of firm being regulated. This is despite the fact that **other important parameters, such as the equity beta, leverage, and required return to debtholders are determined by examining the type of firm being regulated, rather than taking a market wide average.** If, for example, we applied a market-wide average to the estimation of beta, we would use a beta of one for all regulated entities. Aggregate tax statistics can only provide information about the distribution rate of the average company and the utilisation rate of the average shareholder. It may be common commercial practice for businesses such as the regulated entity to distribute franking credits at a higher or lower rate than the average company. Moreover, an individual shareholder can likely use the franking credits or not. That is, the utilisation rate for an individual shareholder is likely to be one or zero – resident investors can use franking credits but non-residents cannot. Since regulated entities are among Australia's largest companies, comparable commercial firms tend to have more foreign investment than the average firm. These differences are not taken into account when examining aggregate taxation statistics. Note that this does not imply that an estimate of gamma should be based on the actual distribution policy of the regulated entity or the actual composition of its shareholder base. In the same way that asset betas and leverage are estimated by reference to comparable commercial entities, gamma should be estimated with reference to evidence from comparable companies, not a market-wide average.

4.2. THERE IS AN INCONSISTENCY WITH THE INTERPRETATION FROM OTHER METHODS

In the *2003 Gas Distribution Review (Draft Decision)*, The Commission correctly notes that there are two elements to the estimation of gamma – the rate at which franking credits are distributed by the firm and the rate at which franking credits are utilized by shareholders. The Commission proposes to multiply these two quantities together in order to estimate gamma (p. 261). The Commission also examines other methodological approaches. This includes examining stock price changes around ex-dividend dates and examining contemporaneous prices of shares and various kinds of derivative securities. All of these other approaches seek to estimate the utilisation rate. They seek to measure how much a shareholder values franking credits that are distributed to them. **These approaches do not estimate gamma, as there is no consideration of the distribution rate.** Yet the heading of this section clearly suggests that these are estimates of gamma. That is, there is an inconsistency between The Commission's definition of gamma when analysing aggregate tax statistics and its definition of gamma when analysing other methodologies.

4.3. MARKET-WIDE AVERAGES IGNORE THE BASIC PRINCIPLES OF EQUILIBRIUM

The basic economic notion of equilibrium suggests that assets will end up being held by those who value them most. Shares in Australian companies will potentially be of more value to domestic investors than to foreign investors. This is because foreign investors will receive returns in the form of dividends and capital gains, but domestic investors will also receive the benefits of dividend imputation credits.[5] This means that, other things equal, domestic investors will be prepared to pay more for the shares than will foreign investors.[6] If all of this is taken as given, two equilibria are possible:

- If there is enough domestic capital available, all of the shares will be held by domestic investors and the share price will be bid up so that dividends plus capital gains plus franking credits jointly provide the required return to investors.

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[5] Of course, there may be mechanisms for foreign investors to extract value from imputation credits, but these mechanisms are costly to implement so that the value of imputation credits to foreign investors is less than the value to domestic investors.

[6] It is always possible that other things are not equal. For example, foreign investors may benchmark returns against a different index or they may see different diversification benefits. However, these are arguments about the market risk premium or beta, not about the value of franking credits. Therefore, this section proceeds on the basis that other things are equal.

- If, however, there is insufficient domestic capital available, some foreign investment will be required. Of course, foreign investors will only provide capital if they receive their required return. This implies a lower share price such that dividends plus capital gains provide the required return to foreign investors. In this scenario, foreign investors receive their required return and domestic investors receive a return that is above what they require. In particular, domestic investors receive the required return from dividends and capital gains (as do foreign investors), and they receive additional value from imputation credits.

Since Australia is a small open economy and a net importer of capital, it is clear that foreign investment is both available and required. Moreover, it is also clear that Australia's largest companies are able to attract, and require, significant foreign capital. This is particularly the case for large infrastructure companies. In fact, the large infrastructure businesses in Australia that are not government owned have substantial foreign ownership. This implies that the *marginal* or *price-setting* shareholder in such a commercial benchmark company is likely to be a non-resident.

The marginal shareholder, whose valuation determines the firm's cost of capital, is the last one willing to contribute funds to the firm. This shareholder will contribute funds and will just receive the required return on their investment. Other things equal, in the case of a firm with majority domestic ownership but significant foreign ownership, the marginal shareholder will be a foreign investor. The domestic investors receive value from imputation credits but the foreign investor does not.[7] Since the foreign investor obtains a return from dividends and capital gains only, these two components of return must satisfy the foreign investor's return requirement, or they will simply not invest. **The firm's cost of capital is not reduced by the value of franking credits because:**

- foreign capital is required; and

- franking credits are worthless to foreign investors.

This proposition simply notes that foreign investors will not be prepared to pay for franking credits that they cannot use – they will not accept a lower return from the company on the basis that they receive franking credits. Thus, franking credits will not affect the firm's cost of capital if foreign investment is required.

Therefore, equilibrium occurs with foreign investors receiving just their required return and domestic investors benefiting from the additional value of imputation credits. This is consistent with the concept of an equilibrium as neither class of investors can receive a better return in a similar investment elsewhere.

[7] Once again, the foreign investor may be able to extract some value from imputation credits, but these mechanisms are costly to implement so that the value of imputation credits to foreign investors is less than the value to domestic investors.

Of course, these arguments are based on the (well-grounded) economic concept of equilibrium. Ultimately, however, the identity of the marginal investor and the value of franking credits is an empirical question. If the marginal investor is a domestic investor who can fully utilise imputation credits, then this will show up in the value of shares in dividend-paying companies. If, as suggested above, the marginal investor receives no value from imputation credits, the empirical evidence will show this. We review the available empirical evidence below.

Aggregate taxation statistics are informative about the distribution of franking credits of the average Australian company and about the utilisation of franking credits of the average shareholder in the average company. This is not at all informative about the effect of franking credits on the WACC of a particular type of company.

The WACC is determined by the marginal price-setting investor who clears the market. The fact that 40% of distributed franking credits are never utilised suggests that a substantial amount of franking credits are distributed to foreign investors, who will not value them.

This is consistent with an equilibrium in which foreign investors are required in the Australian market and are attracted by the payment of an adequate return from the company – they are not attracted by the distribution of franking credits that they cannot use.

In the *2001 Electricity Distribution Review (Draft Decision)*, The Commission (then the ORG) addressed this issue by assuming away the importance of non-residents. For example, pp. 188-9 notes that, "The Office considers that the only practicable benchmark is that of the average Australian investor. If a lower gamma value were used on the basis that the relevant firm or industry has a higher level of foreign participation than the average Australian firm, then consistency would require the same assumption to be reflected in all other benchmarks. This would not be a practicable exercise."

We demonstrate, in Section 5, that this would not be impracticable—the standard domestic CAPM serves as an excellent approximation to the results of an international version of the CAPM.

The Commission further states (p. 189), "if the cost of Australian-sourced equity finance for the distributors was significantly lower than the cost of equity finance from foreign investors (e.g., as a result of dividend imputation), then Australian investors would place a greater value upon the cash-flows generated by the entity. This, in turn, would be expected to result in a sale of the relevant interest to Australian investors. Importantly, such a process would be the outcome of market forces, and would be unaffected by any assumptions as to ownership that might be implied by the regulatory regime."

Here, the implication is that if domestic and foreign investors are identical in all respects except that domestic investors benefit from franking credits and foreign investors do not, then the equilibrium outcome is that the domestic investors would buy out the foreign investors and own 100% of the firm. This is true, unless Australia is a net importer of capital. Which it clearly is. It is clear that foreign investment would be required to finance the large infrastructure businesses that are regulated. The available empirical evidence also confirms this. The notion of equilibrium suggests that if this foreign investment is to be attracted, it must be offered a fair return. This return cannot be reduced by the distribution of franking credits that are of no value to foreign investors. That is, it is entirely

consistent to have domestic investors who value franking credits and foreign investors who don't, all in the shareholder base of a benchmark firm. If they are identical in all other respects, the foreign investors will be the marginal price-setting investor and the firm will receive no reduction in its cost of capital from its distribution of franking credits.

The Commission then goes on to implicitly question whether domestic and foreign investors are identical in all other respects (p. 189), "however, the fact that there is a mixture of Australian and foreign-investor equity participation amongst the Victorian electricity distributors suggest that there is no material difference in the cost of Australian-sourced equity finance relative to equity finance from foreign investors. This in turn suggests that any advantages that Australian equity investors receive through dividend imputation are offset by advantages that are enjoyed solely by foreign equity investors." The "advantages that are enjoyed solely by foreign equity investors" may be in the form of diversification benefits. If investors benchmark against their domestic market index, foreign investors may find the potentially lower correlation with Australian firms to be attractive. However, these are arguments about betas and market risk premiums and have nothing to do with gamma. In particular, we do not need to know anything about how much benefit a foreign investor receives from diversifying into Australia in order to empirically estimate gamma. Indeed none of the approaches that have been used to estimate gamma make any mention of diversification benefits or foreign risk premia. These arguments are distractions to the extent that they relate to theoretical discussions about asset pricing models and do not impact on the empirical estimation of gamma from Australian market data.

We would argue that regulatory transparency requires that the regulator state what asset pricing model is being used. Whatever model is selected, all parameters must then be estimated from the best available market data. In particular, the value of franking credits should be estimated from market prices. Aggregate tax statistics are not market data—they simply tell us the aggregate proportion of investors who cannot use franking credits. This is analogous to survey data. Other CAPM parameters are estimated with reference to market-clearing prices.

5. USING THE DIVIDEND DROP-OFF METHODOLOGY

5.1. BRUCKNER, DEWS, AND WHITE (1994)

The first generation of these papers examine the relationship between the dividend drop-off (the fall in price that occurs on the ex-dividend day) and the nominal value of franking credits that are paid. Bruckner, Dews, and White (1994), for example, argue that the dividend drop-off is informative about the package of the cash dividend plus the franking credit. They regress the drop-off (standardized by share price) on the standardized dividend and standardized face value of the credit. The results for the tax credits show an estimate of 33.5 cents per dollar of face value for 1987-1990, increasing to 68.5 cents per dollar of face value for 1990-1993. Note that these are estimates of the utilisation rate of franking credits for the average ex-dividend day trader in the average company in their sample.

There are at least four reasons why these results should receive little weight in any cost of capital calculation.

- The confidence intervals are so wide as to render the results effectively uninterpretable.

- Since only two observations are available each year for each company, the results are computed cross-sectionally over all companies. This produces an uninterpretable result. Since gamma depends on the nature of the shareholder base, and the composition of the shareholder base differs across companies, we would expect gamma to differ across companies. This methodology produces only a single point estimate – an unevenly-weighted conglomerate across all companies in the sample.

- The data is based solely on the change in the stock price around the ex-dividend date. If trading around this period is dominated by short-term arbitrage traders, this technique will (at best) recover the value of imputation credits for this special class of investors. For purposes of calculating the cost of capital, the value of imputation credits to longer-term investors – the providers of capital to the firm – is what is required.

- If the vast majority of dividends in the sample are fully franked and if the corporate tax rate is approximately constant over the sample period, the explanatory variables will be highly collinear so that the results are uninterpretable. This is not a matter of conjecture or opinion, it is a statistical fact. Note that the form of the regression model used is:

$$\frac{S_{ij}(t)-S_{ij}(t-1)}{S_{ij}(t)}=\beta_0+\beta_1\frac{D_{ij}(t)}{S_{ij}(t)}+\beta_2\frac{IC_{ij}(t)}{S_{ij}(t)}+\varepsilon_{ij}(t).$$

The left-hand side, $\frac{S_{ij}(t)-S_{ij}(t-1)}{S_{ij}(t)}$, is the dividend drop-off and there are two right-hand side variables; the cash dividend, $\frac{D_{ij}(t)}{S_{ij}(t)}$, and the imputation credit, $\frac{IC_{ij}(t)}{S_{ij}(t)}$. All variables are scaled by the stock price. Now suppose that all dividends in the sample are fully franked and that the corporate tax rate, τ_C, is constant at 36 percent. In this case, the imputation credit is

$$IC_{ij}(t)=\frac{\tau_C}{1-\tau_C}=0.56$$

for all observations. Thus the regression model becomes:

$$\frac{S_{ij}(t-1)-S_{ij}(t)}{S_{ij}(t)}=\beta_0+\beta_1\frac{D_{ij}(t)}{S_{ij}(t)}+\beta_2\frac{0.56D_{ij}(t)}{S_{ij}(t)}+\varepsilon_{ij}(t)$$

in which case β_1 and β_2 are not separately identifiable because the two right-hand side variables are linear transforms of each other – one is simply 0.56 times the other. This multicollinearity can still be a concern even if there are changes in the corporate tax rate and not all of the dividends in the sample are fully franked. If most of the dividends are fully franked and changes in the tax rate are small, the two right-hand side variables will be highly correlated. This violates one of the key assumptions that are required for statistical inference in a least squares setting. The result is that β_1 and β_2 are not separately identifiable. An indication of this problem is found in the estimates for the 1990-93 period in which the value of cash dividends is found to be *lower* than the value of imputation credits. Given that franking credits can only be used by a subset of investors and receive the same tax treatment as dividends, it is hard to image any plausible scenario in which this is possible.

In particular, for the 1990-93 period, Bruckner, Dews, and White (1994) estimate a value of 0.618 for cash dividends and 0.685 for imputation credits. Thus, we have $\beta_1=0.618$ and $\beta_2=0.685$. But note that we obtain exactly the same result with $\beta_1=1.0016$ and $\beta_2=0$. This is because:

$$0.618\frac{D_{ij}(t)}{S_{ij}(t)}+0.685\frac{0.56D_{ij}(t)}{S_{ij}(t)}=1.0016\frac{D_{ij}(t)}{S_{ij}(t)}+0\frac{0.56D_{ij}(t)}{S_{ij}(t)}.$$

That is, if we assume that cash dividends are fully valued by those who trade around ex-dates (consistent with a wealth of international evidence on this point)[8], the results suggest that imputation credits are of negligible value. These two interpretations are observationally equivalent and we can't tell which is right, because the presence of multicollinearity makes inference of individual coefficients impossible. We can, however, say that one is consistent with numerous research papers on the value of cash dividends, and one is not.

In summary, the well-known problem of multicollinearity renders interpretation of individual coefficients impossible in this setting. The joint effect of dividends plus imputation credits can, however, be estimated robustly. The question is then one of how best to decompose this joint effect. A large body of evidence suggests that cash dividends are fully valued by those who trade around ex-dates. If this piece of evidence is coupled with the estimate of the joint effect of dividends and imputation credits, the implication is that imputation credits have negligible value. **Thus, although this paper has been relied on to support the use of relatively large values for gamma, proper interpretation of the results (in light of these statistical issues) would suggest the opposite.**

5.2. HATHAWAY AND OFFICER (2002)

Hathaway and Officer (2002) include an analysis similar to Bruckner, Dews and White (1994) in which they regress the dividend drop-off ratio against the degree of franking. The regression estimates in this study have to be interpreted with caution as the independent variable (the proportion of the dividend that is franked) is bi-modal with spikes at zero and one and with relatively few observations in between. This means that the intercept and the slope are potentially sensitive to a small number of influential observations, when different periods or different filters are used. Indeed the authors themselves express reservations about their results in the period after superannuation funds became subject to income tax of 15 percent, and were therefore able to utilize imputation tax credits. Whereas these tax changes lead to an expectation of an increased demand for franking credits, their results showed a decrease in the implied value of credits while the value of unfranked dividends appeared to double.

The effect of multicollinearity between the dividend amount and franking credits is also apparent in this paper. Hathaway and Officer separate their sample by size and sector, and report the following values for dividends and franking credits.

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[8] See, for example, Kalay, A. (1982). "The Ex-Dividend Day Behaviour of Stock Prices: A Re-Examination of the Clientele Effect." Journal of Finance **37**(4): 1059-1070.
, Barone-Adesi, G. and R. Whaley (1986). "The Valuation of American Call Options and the Expected Stock Price Decline." Journal of Financial Economics **17**: 91-111.
, Michaely, R. (1991). "Ex-Dividend Day Stock Price Behavior: The Case of the 1986 Tax Reform Act." Journal of Finance **46**(3): 845-859.
All of these papers demonstrate that a one dollar cash dividend is associated with a one dollar stock price decline – cash dividends are fully valued by those who trade around dividend ex-dates.

Sector	Small		Large		All	
	Div	FC	Div	FC	Div	FC
Industrials	0.86	0.17	0.80	0.49	0.83	0.30
Resources	0.55	0.70	0.72	0.44	0.61	0.61
All	0.71	0.41	0.77	0.49	0.74	0.44

This suggests that a dollar of cash dividend is worth 55 cents if received from a small resources company, but 86 cents if received from a small industrial company. However, it is difficult to fathom any reason why investors would value franking credits so much more highly if distributed by resource firms than by industrial firms. These results also suggest that investors in small resources companies value franking credits more than cash dividends. Again, it is difficult to fathom any scenario in which investors would value franking credits more than cash since franking credits provide the opportunity for some investors to save tax in the future while cash dividends provide an immediate benefit to all shareholders. These perverse results are, of course, driven by multicollinearity between dividends and franking credits. Since franking credits are essentially a multiple of dividends, it is very difficult to separately value these two components.

It is, however, possible to robustly value the sum of dividends and franking credits. Indeed, the value of the package of dividends and franking credits (relative to the dividend) can be re-calculated from the results of Hathaway and Officer as follows:

Sector	Small	Large	All
Industrials	0.97	1.11	1.02
Resources	1.00	1.00	1.00
All	0.97	1.08	1.02

In their sample, the majority of observations occur under a 39 percent corporate tax rate. Thus a $1 dividend is most commonly associated with a (0.39/1 – 0.39) = 64 cent franking credit. These, re-stated results suggest that a $1 dividend and an accompanying 64 cent franking credit are associated with a drop of around $1 in the stock price. This is remarkably consistent across company size and sector.

Of course, multicollinearity prevents us from being able to split this $1 value between dividends and franking credits. We do, however, note that this result is consistent with cash dividends being fully valued and franking credits being worthless, in the hands of the marginal investor. Moreover, there is a wealth of evidence from U.S. markets to suggest that cash dividends are fully valued[9]. **Thus, a coherent and consistent interpretation of all of these results is that cash dividends are fully**

[9] See Barone-Adesi and Whaley (1986), Michaely (1991) and Boyd and Jagannathan Boyd, J. and R. Jagannathan (1994). "Ex-Dividend Price Behavior of Common Stocks." Review of Financial Studies 7(4): 711-741.

valued and franking credits are worthless in the hands of the marginal investor trading around dividend ex-dates.

Finally, it should be noted that in its discussion of Hathaway and Officer (1999 version) in the Review of Gas Access Arrangements: Draft Decision (2002), the Commission inflated the estimates of the value of distributed franking credits by around 25%. In footnote 374 (p. 263) the Commission explains that this was done to "allow for differences between the tax rate on capital gains and dividends" and refers to a formula for this purpose derived by Walker and Partington (1999). **The Commission has provided this adjustment even though the authors themselves found it to be unnecessary. Moreover, even Walker and Partington who derive the formula find such an adjustment to be unnecessary.** In discussing this point they note (p. 283) that " Australian taxpayers are generally taxed at their marginal income tax rate on capital gains, or if they are share traders their capital gains are taxed as income. Therefore, it seems plausible that [the tax rate on dividends] will equal [the tax rate on capital gains] at the margin." There are three problems with the adjusted figures on which the Commission has relied:

1. The precise definition of the adjustment and the parameter values used for the different personal tax rates have never been released by the Commission. What data was used to estimate the tax parameters, or was the adjustment made on the basis of assumed values?

2. The Commission has adjusted the estimate for one paper only. Moreover, the authors of that paper did not believe that such an adjustment was required, nor have they made such an adjustment in their 2002 revision. The authors who derive this adjustment also believe that no such adjustment is necessary in practice. It is highly likely that the sharp increase in trading that occurs around ex-dividend dates is driver by traders (foreign and/or domestic) who are taxed equally on dividends and capital gains.

For these reasons, the Commission should be more transparent when it adjusts the results of academic research.

5.3. BELLAMY AND GRAY (2004)

In a recent paper, Bellamy and Gray (2004) examine methodological and statistical issues relevant to the dividend drop-off methodology. This is because the dividend drop-off framework has provided the empirical support for the regulatory practice of setting $\gamma = 0.5$.

This paper is currently being peer-reviewed at the *Review of Financial Studies* and a full copy of the paper is attached as Appendix Two.

A summary of the key findings are as follows:

- The precise econometric methodology that is employed to analyse stock price changes around ex-dividend dates can have a significant impact on results. The simple technique that has been used in past papers is not as robust as a generalised least squares (GLS) technique that places more weight on more informative observations.

- Even using this more robust technique, multicollinearity between dividends and franking credits remains a problem. It is difficult to separately estimate the value of each component. However, a single value for the package of dividends and franking credits can be reliably estimated.

- When a $1 dividend and a 43c franking credit (at a corporate tax rate of 30 percent) are paid, stock prices fall, on average, by $1. This is consistent with dividends being fully valued and franking credits being worthless to the price-setting investor.

- Other empirical work suggests that cash dividends are fully valued in other markets. "A one-for-one price drop has been a good rule of thumb for the last several decades".

- When tax rates change, the amount of franking credits changes (43c at 30 percent, 51c at 34 percent, and 56c at 36 percent) but the value of the package of dividends plus franking credits does not. In the first regime a fully-franked dividend consists of $1 of cash and a 43 cent franking credit. This package is valued by the market at $1. In the second regime a fully-franked dividend consists of $1 of cash and a 51 cent franking credit. This package is valued by the market at $1. In the third regime a fully-franked dividend consists of $1 of cash and a 56 cent franking credit. This package is valued by the market at $1. This is inconsistent with franking credits being valued by the marginal price-setting investor. It is, however, straightforwardly consistent with the notion that a $1 cash dividend is worth $1.

- A constrained model in which dividends are fully valued and franking credits are not valued explains the data as well as any unconstrained model. That is, the same data that has been used as the basis for setting gamma equal to 0.5 cannot statistically reject the hypothesis that franking credits are worthless to the marginal price-setting investor.

- Even employing the simple empirical technique of past papers and in spite of multicollinearity issues, the estimate of the value of franking credits would be zero, if 30 of over 6,000 observations were removed. That is, even if multicollinearity issues were ignored, the apparent value of franking credits would disappear entirely if 30 influential observations were removed. That is, the result that franking credits have some value is not only statistically unreliable, it stems from a handful of outliers. If these few observations (less than half of one percent of the sample) were

removed, the result disappears entirely in favour of an estimate of zero for the value of franking credits.

Bellamy and Gray (2004) conclude by noting that "the available data cannot reject the hypothesis that franking credits are not valued by the price-setting investor".

The available data and the dividend drop-off methodology are unable to reject the hypothesis that franking credits are not valued by the marginal price-setting investor in the average Australian company.

A coherent and consistent interpretation of the dividend drop-off results is that cash dividends are fully valued and franking credits are worthless in the hands of the marginal investor trading around dividend ex-dates. This implies that franking credits do not affect the cost of capital of the average Australian firm.

5.4. BROWN AND CLARKE (1993)

Brown and Clarke (1993) use a dividend drop-off methodology similar to that of Officer and Hathaway and Officer (2002). They examine two sub-periods and report confidence intervals for the estimated value of distributed franking credits for each. Noise in security prices causes the sampling error of the estimates to be considerable. The 95% confidence interval for the value of distributed franking credits is -12.44% to 24.52% between 1987 and 1989 and 38.46% to 103.68% between 1989 and 1991. They suggest a possible explanation for the large difference in the results between the two periods: "The marked increase in the value of the franking variable in the later period might reflect a greater ability of the market, on average, to access the value of tax credits." An alternate explanation is an increase in multicollinearity in the second period as tax rates are effectively constant and fully franked dividends dominate the sample.

It should also be noted that the entire sample period is prior to the 1997 introduction of the 45-day rule. Even the results from the second sub-period are not dissimilar to those of Cannavan, Finn, and Gray (2004), who estimate the value of distributed franking credits to average up to 50% of face value in the pre-1997 period.

6. USING INFORMATION FROM TRADED SECURITY PRICES

A number of more recent papers attempt to infer the value of imputation credits from the prices of traded securities. Two such papers, which were discussed by The Commission in the *2003 Gas Distribution Review (Draft Decision)*, are reviewed below.

6.1. FUTURES DATA

The two studies that utilise futures data to infer the value of imputation credits are Cannavan, Finn and Gray (2004) and Twite and Wood (2002).

Cannavan, Finn, and Gray (2004) compare the prices of individual share futures (ISF) contracts and low exercise price options (LEPO's) with the prices of the underlying shares to infer the value of cash dividends and imputation credits. This can be done because dividends attach to the shares but not the ISF's or LEPO's. This technique has several advantages over the dividend drop-off regression technique:

- Every time an ISF or LEPO trades within one minute of a trade in the underlying share, it is possible to infer the value of dividends and imputation credits. Thus, instead of two observations each year for each company, there are potentially thousands. This increased sample size brings statistical benefits and also enables calculations to be done on a company-by-company basis.

- ISF's and LEPO's trade well in advance of ex-dividend dates, so prices are not contaminated by the activities of short-term arbitrage traders.

The results of this paper suggest that market participants place a low value on imputation credits, particularly since the 1997 introduction of the 45-day holding period rule. In particular, for a number of large Australian companies with significant foreign ownership, the results suggest that imputation credits are effectively worthless to the marginal investor, at least since the introduction of the 45-day holding period rule made it more difficult to transfer these credits. **This implies that setting gamma equal to zero is more appropriate than assuming a 50 percent value.**

Moreover, this result can also be interpreted as evidence that the marginal (price-setting) investor in these large Australian firms is a non-resident investor who is unable to extract value from imputation credits under the 45-day rule. This implies that recent changes to Australian tax laws to allow investors a rebate for unused imputation credits will have no effect on the value of gamma or a firm's cost of capital. This is because this change to Australian tax laws has no effect on non-resident

investors. If the price-setting investor is not an Australian resident, the recent change is irrelevant to their valuation of imputation credits.

In the 2002 Review of Gas Access Arrangements: Draft Decision the Commission made a number of specific comments relating to an earlier version of this paper. First, the Commission suggested that "the estimates are restricted to that limited sample" (p. 265). This is true. The firms analysed in the sample are large firms with significant foreign ownership – as are the Distribution Businesses that are the subject of the current analysis. For the reasons stated above, this is an advantage rather than a limitation. For the same reason that we restrict the sample of comparable firms when estimating betas, we must restrict the sample that is analysed when estimating gamma. When estimating betas the restriction is on the dimension of industry/systematic risk, and when estimating gamma the restriction should be on the dimension of shareholder base.

Second, the Commission stated that this paper "assumes that the share is sold at the expiry of the future/LEPO, tax paid on the trading profit, rather than held for a period, and the lower rates of capital gains tax availed of" (p.265). This illustrates a mis-understanding of the concept of no-arbitrage pricing. The idea is that the payoff on a derivative contract can be replicated by a particular trading strategy that involves borrowing money and dynamically trading the underlying stock. Because both strategies produce the same payoff, they must sell for the same price, or else an arbitrage opportunity is available. Therefore, we need to develop a dynamic trading strategy that mimics the payoff of the future/LEPO, and this is what is done in the paper. The Commission's comment suggests that it might be preferable to hold the underlying stock for a longer period for tax reasons. This may be true, but it is irrelevant. No-arbitrage pricing requires a strategy that mimics the payoff of the derivative, not a strategy that might save some tax. Finally, it should be noted that the no-arbitrage valuation framework forms the basis of the industry-standard futures cost-of-carry formula and the Nobel prize-winning Black-Scholes option pricing model.

Since the last ESC distribution determination, this paper has been published in the leading *Journal of Financial Economics*. The paper concludes (p. 193) that, "in a small open economy such as Australia, the company's cost of capital is not affected by the introduction of a dividend imputation system. The company must produce the same return for the marginal stockholder whether an imputation system exists or not if the marginal stockholder receives no value from imputation tax credits".

Twite and Wood (2002) also examine individual share futures contracts using a similar methodology. Their sample period is small, and ends in 1995 – well before the introduction of the 45-day rule. Their results are consistent with those of Cannavan, Finn, and Gray (2004) in that they report a value of distributed franking credits of up to half the face value prior to 1997.

6.2. OTHER DATA SOURCES

Another paper that attempts to infer the value of imputation credits from the prices of traded securities is Chu and Partington (2001). This paper compares the prices of shares with different

dividend entitlements consequent to rights issues. The "old" shares are entitled to receive the dividend but the "new" shares are not. The authors conclude that the value of imputation credits is higher than that reported by Cannavan, Finn, and Gray (2004). There are several reasons for this:

- The sample of Chu and Partington (2001) consists of only 26 rights issues over a 10-year period, of which 16 were banking or investment stocks.

- The authors conclude that the implied value of the grossed-up dividend is 150 percent of the cash dividend, which means that imputation credits are almost fully valued. But the standard error is 97 percent, so this estimate is not statistically different from either 0 or 1. That is, we cannot reject the hypothesis that imputation credits are worthless, or even that cash dividends are worthless. Although the mean is 150 percent, the range is from –375 to 951 percent. Such imprecise estimates based on such a small sample should be interpreted with great caution.

- The rights are in fixed supply and represent a small fraction of the total shares outstanding in any of the sample companies. This provides a mechanism for a type of dividend streaming – holders of the old shares received a fully-franked dividend and holders of the new shares receive no dividend and consequently the stock price is reduced. The result is likely to be a separation of ownership so that those who value dividends and imputation credits greatest will congregate in the old shares and those who cannot benefit from imputation credits will congregate in the new shares. This effect is likely to drive a greater difference between the two classes as the characteristics of the shareholder base of the old shares is temporarily altered by the ability to stream dividends.

In a similar vein, Chu, Lonergan, Partington, and Stewart (2001) examine a small sample of rights issues and make similar conclusions.

Walker and Partington (1999) examine a special market available at the ASX that allows investors to simultaneously trade shares with and without a dividend. Volumes traded through these special side markets are extremely small and the market exists only for a very small number of shares. While the authors report that the value of franked dividends exceeds the face value of the dividend itself, on average, there is extremely wide variation in the estimates for different ex-dividend events. This is curious given that the shares trade with and without the dividend simultaneously. Such noise is expected in dividend drop-off studies as there are other reasons (new information) for prices to change between the cum- and ex-dividend dates. In this market, however, there is no reason other than the dividend for the prices of the two securities to differ, yet there is wide variation in the implied values of dividends and franking credits. This seems to suggest that the trades may be structured to produce tax benefits between related parties and may not reflect competitive market forces.

One point to note in regard to all of these papers is that none claim to estimate the value of franking credits explicitly. Professor Partington is, rightfully, careful only to state the estimated value of the package of dividend and franking credit relative to the size of the cash dividend. Recognising the importance of the problems of multicollinearity, he does not explicitly offer views on how much of this package value can be attributed to each component.

A final point to note is that almost the entire data samples examined in these papers pre-date the 1997 45-day rule. Even Cannavan, Finn, and Gray (2004) report that franking credits appear to have some value prior to the introduction of the 45-day rule, although this is no longer relevant.

7. CONCLUSION

In summary, the most comprehensive and persuasive empirical evidence suggests that for a number of large Australian companies with significant foreign ownership, imputation credits are effectively worthless to the marginal investor, at least since the introduction of the 45-day holding period rule made it more difficult to transfer these credits. In light of the totality of the conceptual arguments made above and the most recently available empirical evidence, it is difficult to justify using a value of gamma above zero..

In particular, we would advocate that:

1. The Commission should continue to use the standard CAPM to compute the cost of equity capital.

2. The best available *market* data be used to estimate every parameter consistently—as market prices are all determined by the marginal price-setting investor in that market, and

3. The best market data suggests that gamma should be set at zero:

    i. Aggregate tax statistics are not market data.

    ii. Dividend drop-off studies cannot reject the notion that franking credits are not valued.

    iii. The only paper published in a Tier 1 journal clearly establishes that gamma should be set at zero for a sample of firms that are similar in many respects to those that are regulated.

8. CLARIFYING THE PROCESS FOR STAKEHOLDERS

This paper has concluded that the appropriate value to attribute to imputation credits is zero. In considering the various studies that the ESC has previously made reference to in its assessment of γ and arriving at this conclusion, SFG has applied a structured approach and rationale which considers the merits of each study based on a number of criteria. This approach is summarised in the table below.

Paper	Data Post 1997	Method allows for franking credits to have different values in different types of firm.	Large number of observations	Published in Tier 1 Journal
Hathaway and Officer (2002)	No	No	Yes	No
Brown and Clarke (1993)	No	No	Yes	No
Bruckner, Dews, and White (1994)	No	No	No	No
Walker and Partington (1999)	No	No	No	No
Twite and Wood (2002)	No	Yes	No	No
Cannavan, Finn, and Gray (2004)	**Yes**	**Yes**	**Yes**	**Yes**
Chu and Partington (2001)	Yes	No	No	No
Chu, Lonergan, Partington, and Stewart (2001)	Yes	No	No	No
Bellamy and Gray (2004)	Yes	No	Yes	No

In the event that the ESC consider the same evidence and arrives at a different conclusion, it would be helpful to understand why the Commission has reached a different result. In this regard, SFG recommends that AGL should seek clarification on the following matters:

- Does The Commission give more weight to empirical papers that have been peer-reviewed and published, relative to unpublished working papers?

- Does The Commission give more weight to empirical work that has been published in top-tier finance journals relative to papers published in third-tier local journals?

- Does The Commission consider the sample size and how comparable the sample firms are to the regulated entity in determining how much weight to place on a particular empirical paper?

- Does The Commission have a preference for a particular type of data or methodology? Is evidence from aggregate tax statistics, stock price changes around dividend ex-dates, or implied values from the prices of traded securities most informative?

- Some Australian regulators note that it is possible for some studies to be "more valid than others" (*NSW Electricity Pricing Determination,* p. 223). Are any of the studies on the value of franking credits more valid than others? Why? Are more valid studies given more weight?

- Does The Commission give more weight to regulatory precedent or empirical evidence from market data? Why?

- Does The Commission consider that market prices are set at the valuation of the marginal investor, whose trade balances demand and supply and clears the market?

- Does The Commission accept that different investors in the Australian capital market would place different values on government bonds? If so, how would the average of these valuations be computed?

Does the Commission accept that it is desirable for papers that propose to estimate the value of franking credits to (i) examine post-1997 data to include the impact of the 45-day rule, (ii) allow for franking credits to have potentially different values in different types of firms (as is done for beta, leverage, and credit rating) (iii) use a large number of observations in their analysis, and (iv) be published in a Tier 1 journal?

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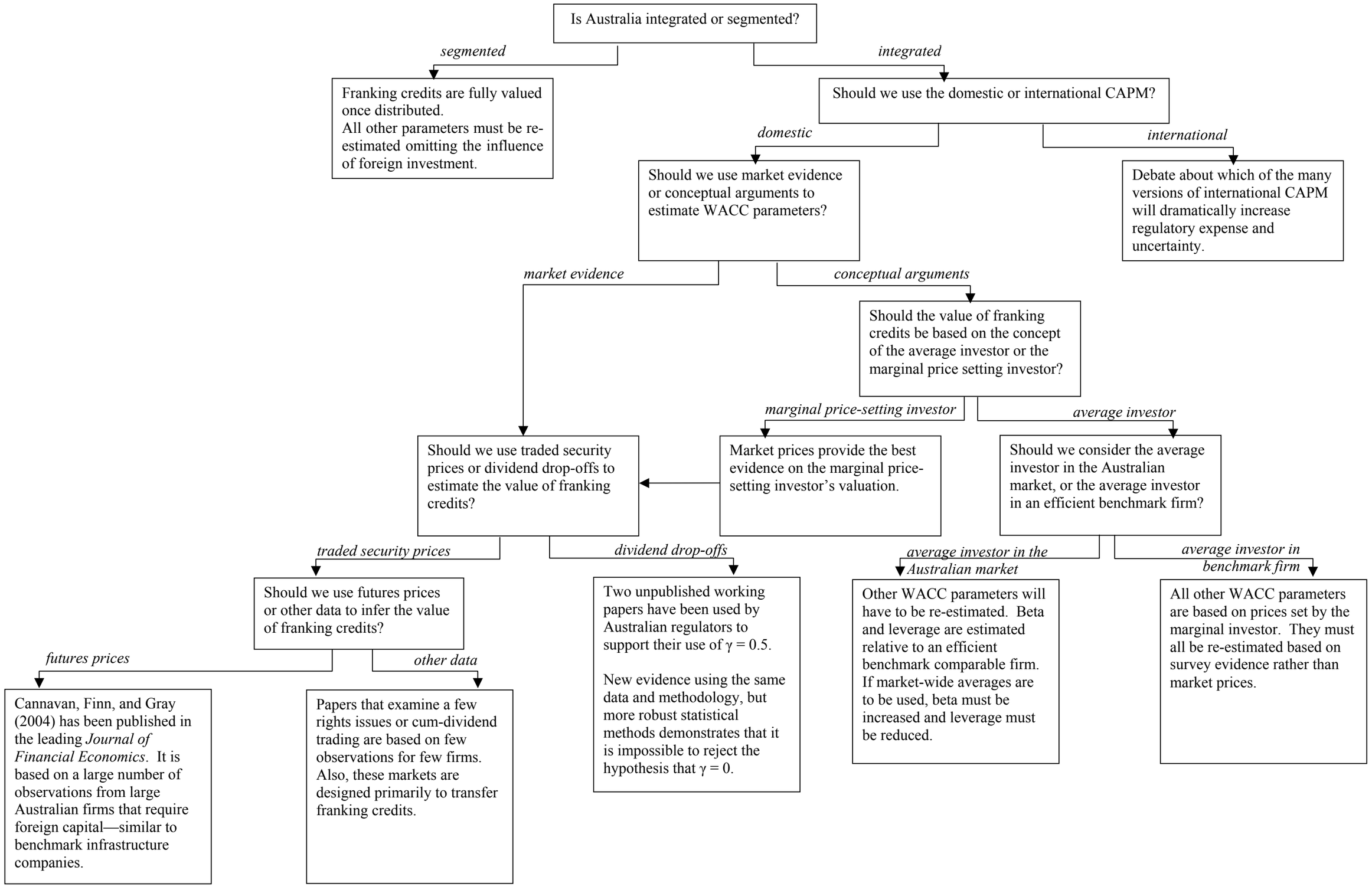
Figure 1: Structure of Arguments Relating to the Value of Franking Credits.



Using Stock Price Changes to Estimate the Value of Dividend Franking Credits

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ABSTRACT

The change in share prices around ex-dividend dates is frequently used to estimate the value of cash dividends and the associated tax credits that are used to rebate corporate taxes in a dividend imputation system. We show that the estimates from this procedure are *highly* sensitive to the choice of econometric method and to sample selection issues. We draw conclusions about the optimal empirical techniques from a comprehensive simulation exercise. Application of this technique to Australian data suggests that it is difficult to separately estimate the values of cash dividends and associated tax credits—a point that is largely ignored in the extant literature. In contrast, to prior work, we show that the most appropriate interpretation of the data is that cash dividends are fully valued and the associated tax credits are worthless to the marginal trader around the ex-date.

JEL Classification: G31, G38.

Keywords: Dividend drop-off, dividend imputation tax credits, cost of capital.

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ABSTRACT

The change in share prices around ex-dividend dates is frequently used to estimate the value of cash dividends and the associated tax credits that are used to rebate corporate taxes in a dividend imputation system. We show that the estimates from this procedure are *highly* sensitive to the choice of econometric method and to sample selection issues. We draw conclusions about the optimal empirical techniques from a comprehensive simulation exercise. Application of this technique to Australian data suggests that it is difficult to separately estimate the values of cash dividends and associated tax credits—a point that is largely ignored in the extant literature. In contrast, to prior work, we show that the most appropriate interpretation of the data is that cash dividends are fully valued and the associated tax credits are worthless to the marginal trader around the ex-date.

1. Introduction

The effect of taxes on the value of dividends is an issue that has received much attention in the literature yet still remains a controversial issue. The most common approach is to draw inferences about the relative value of dividends and capital gains from the ex-dividend price drop-off. This drop-off is conventionally defined as the ratio of the change in price between cum- and ex-dividend prices, to the dividend amount. Elton and Gruber (1970) suggest that the dividend drop-off ratio can be used as an estimate of the value of dividends relative to capital gains for the firm's marginal shareholder. They interpret their drop-off estimate of 0.77 as evidence that, for the marginal investor, the tax on dividends is 23% greater than on capital gains. This interpretation has been challenged on at least four grounds.

First, Kalay (1982) and others have argued that dividend ex-dates attract significant trading volume from short-term arbitrage traders. For any individual or institution for whom tax rates on dividends and capital gains are equal, the appropriate drop-off is 100%. If dividend drop-offs were regularly less than 100%, these investors would be motivated to buy the stock cum-dividend, receive the dividend, and sell it ex-dividend. Consistent with this idea, Lakonishok and Vermaelen (1986) document significant increases in volume around ex-dividend events. This implies that the dividend drop-off is a measure of the relative value of dividends versus capital gains to short-term arbitrage traders, rather than the marginal long-term investor in the firm.

Second, Boyd and Jagganathan (1994) note that different investors in the shareholder base (including short-term arbitrage traders) will have different relative values of dividends versus capital gains because relative tax rates and transaction costs vary across investors. They develop a costly arbitrage equilibrium model of the tradeoff between dividends and capital gains. They note that the relative values of these two forms of return will depend upon the composition of the shareholder base, ease and cost of arbitrage activity, and the dividend yield. They argue that all of these factors should be considered when estimating and interpreting dividend drop-offs, but that "a one-for-one drop-off is a useful rule of thumb" over their sample period.

Third, Frank and Jagganathan (1998) note that microstructure effects might affect the estimation of drop-offs. They examine the Hong Kong market where dividends and capital gains are tax-free to

all investors. Whereas this would suggest a drop-off of 100% for all investors, their measured drop-off is significantly less. They attribute this to microstructure effects – the pattern of buy and sell orders before and after the dividend combined with the effect of a bid-ask spread. Bali and Hite (1998) show that where prices are constrained to discrete tick multiples and dividends are continuous, the drop-off is expected to be less than the amount of the dividend. It is, therefore, unclear whether a relatively small drop-off should be interpreted as a tax-induced preference for capital gains, or as the result of microstructure effects. Whereas the first two criticisms deal with the *interpretation* of the drop-off estimate, this relates to its *measurement*.

Fourth, another measurement issue is that papers in this area tend to report wide confidence intervals around drop-off estimates. Moreover, for individual observations the drop-off can be more than 10 times the dividend amount in either direction. Thus, even if we knew how to properly interpret the result, the estimate of the drop-off can be imprecise.

All of these issues are perhaps even more pronounced in a dividend imputation tax system. Under a dividend imputation tax system, corporate tax can be imputed against personal tax obligations on dividend income. This effectively removes the "double-taxation" of dividends that exists under a classical tax system. When a dividend is paid out of corporate profits that have been taxed (domestically) at the statutory corporate tax rate, the shareholder receives the cash dividend plus an imputation tax (or "franking") credit. This tax credit can be used to offset personal income tax obligations. A number of attempts have been made to adapt the dividend drop-off methodology to estimate the value of imputation tax credits. Much of this work emanates from Australia, where a full dividend imputation tax system has operated since 1986. This literature is reviewed in Section 2.

The value of these imputation tax credits is important as Officer (1994) demonstrates that their value to the marginal stockholder is an important element of firm valuation. The marginal investor's value of these tax credits is the basis of an adjustment to the firm's cash flows or to its weighted-average cost of capital. Officer illustrates both of these approaches and provides the framework for much of the existing research in the area.

In a classical tax system, the relative value of dividends and capital gains has implications primarily for the firm's dividend policy. Officer (1994) shows that dividend imputation tax credits also have a potential effect on corporate taxes. In the same way that tax deductibility of interest payments has an important effect on the firm's after-tax cost of debt, imputation tax credits have a potentially important effect on the firm's cost of equity. Therefore, an accurate measure of the value of imputation tax credits is required for investment, financing, *and* dividend decisions. In practice, therefore, it is likely to be even more important to accurately value imputation tax credits than it is to measure the relative value of dividends and capital gains. Moreover, this issue is of increasing global significance as most developed economies either have, or are considering the introduction of, some form of dividend imputation system[1].

Unfortunately, the problems that exist in estimating and interpreting dividend drop-offs in a classical tax system also exist and are even more severe in an imputation setting. This is because there are two potential systematic reasons for an ex-date stock price decline—the value of the dividend itself and the value of the associated tax credit. This presents two problems: (i) estimating the drop-off, and (ii) decomposing it into these two components. These two problems are the focus of this paper. In particular, we use a comprehensive simulation exercise to show that different econometric designs and sample screening procedures that have been used in prior studies can have a dramatic influence on the estimates of the values of dividends and franking credits.

Using a sample of 5640 Australian dividend ex-dates from 1995 to 2002, we show that different research design and sample screening procedures can generate estimates of the value of franking credits anywhere between zero and 60%. Clearly, the results of any drop-off study must be interpreted with caution. While we make some recommendations about research design, our ultimate conclusion is that it is difficult to separately estimate the values of cash dividends and franking credits. If cash dividends are assumed to be fully valued (as they are in other markets) the data suggests that franking credits are worthless to the marginal trader around the ex-date. Indeed a constrained model in which cash dividends are fully valued and franking credits are worthless fits

[1] Australia, Finland, New Zealand, Norway, and Mexico operate full imputation systems in which all of the corporate tax paid can be offset against personal tax obligations. Germany operated a full imputation system until October 2000. Many other countries (e.g., Canada, France, Ireland, Italy, and the U.K.) operate partial imputation systems in which part of the corporate tax paid can be offset against personal tax obligations.

observed dividend dropoffs as well as any unconstrained model. The data are unable to reject this constraint.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature on the market valuation of cash dividends and imputation tax credits with specific emphasis on dividend drop-off methodologies. Section 3 surveys the various empirical procedures that have been used to estimate dividend drop-offs in classical and imputation systems. Section 4 contains a comprehensive simulation exercise that illustrates the strengths and weaknesses of a wide range of empirical techniques. Section 5 applies these empirical techniques to an Australian data set and Section 6 concludes.

2. Inferring the Market Value of Dividends and Imputation Tax Credits

In this section, we review the conclusions and implications of the relevant literature. Empirical and methodological details are the focus of the subsequent section.

2.1. Dividends

Early research by Campbell and Beranek (1955) and Durand and May (1960) documents ex-dividend stock price declines that are less than the face value of the dividend but are so weakly significant as to be thought consistent with Miller and Modigliani's (1961) dividend irrelevance theorem for a (tax-free) perfect capital market.

Elton and Gruber (1970) popularize the use of the ex-dividend price drop-off to examine the issue of dividend valuation and taxes. The drop-off ratio is conventionally defined as the ratio of the change in price between cum- and ex-dividend prices, to the dividend amount. Their tax differential hypothesis posits that prices are set such that the marginal investor is indifferent between trading cum-or ex-dividend. Since the marginal investor in a classical tax system is usually assumed to be taxed more highly on dividends than on capital gains, the drop-off ratio is expected to be less than one.

Kalay (1982), however, argues that any deviation of the expected ex-dividend price change from the amount of the dividend would create arbitrage opportunities for short-term traders (arbitrageurs)

who are equally taxed on dividends and capital gains. Michaely (1991) also presents evidence consistent with ex-dividend day drop-offs being driven by short-term dividend capture strategies associated with arbitrage activity. In response, Elton, Gruber, and Rentzler (1984) argue that Kalay ignores some transaction costs, which largely restrict short-term traders from dominating ex-dividend price setting.

Boyd and Jagannathan (1994) note that the data used in dividend drop-off studies usually contain a mixture of observations with and without arbitrageurs and dividend capturers active. They develop a costly-arbitrage equilibrium framework that results in the prediction of a non-linear relation between the percentage price drop and the dividend yield. This prediction is supported empirically and the marginal price drop is not significantly different from the dividend amount. They conclude (p. 711) that "over the last several decades, a one-for-one marginal price drop has been an excellent (average) rule of thumb."

2.2. Imputation Tax Credits

Brown and Walter (1986) study ex-dividend behavior in the pre-imputation Australian market. The average drop-off ratio of Australian shares is found to be about 0.75, suggesting that the Australian market had been discounting dividends to capital gains by approximately 25%. Wood (1991) finds no evidence that the drop-off ratio is related to the actions of tax arbitrageurs over the ex-dividend day period. He does, however, note that the drop-off ratios for particular investment groups differed according to firm market capitalization and industry classification. Highly capitalized resource shares for instance, had drop-off ratios that were in line with the actions of foreign investor groups. The drop-off ratios for high capitalization industrial shares indicated that the marginal shareholder is tax exempt.

Brown and Clarke (1993) hypothesize that the drop-off ratio would increase after the introduction of the imputation system if imputation credits have a positive value. Using a model based on Elton and Gruber (1970) but extended to incorporate dividend imputation, they find that both the conventionally defined drop-off ratio, and the drop-off ratio grossed-up for imputation credits actually declined immediately following the introduction of the imputation system. This situation did reverse somewhat from fiscal year 1989 although the grossed-up drop-off ratios were

significantly less than one after the imputation system was introduced. The implication from these results is that imputation tax credits are valued at considerably less than their face value.

Hathaway and Officer (1992) examine dividend drop-off ratios on the ex-dividend date. They regress the dividend drop-off ratio against the degree of franking and the coefficients from the regression implied a value of one dollar of distributed tax credits of between 77 and 82 cents. The authors themselves express reservations about their results in the period after superannuation funds became subject to income tax of 15%, and were therefore able to utilize imputation tax credits. Whereas these tax changes lead to an expectation of an increased demand for franking credits, their results showed a decrease in the implied value of credits while the value of unfranked dividends appeared to double.

Bruckner, Dews, and White (1994) regress the drop-off (standardized by share price) on the standardized dividend and standardized face value of the credit. The results for the tax credits show an estimate of 33.5 cents per dollar of face value for 1987-1990, increasing to 68.5 cents per dollar of face value for 1990-1993. The value of dividends for the later period is found to be lower than the value of tax credits at 61.8 cents. Given that franking credits can only be used by a subset of investors and receive the same tax treatment as dividends, they are unlikely to be more valuable than cash dividends. One reason for this apparently anomalous result is that almost all of the dividends in their later sample were fully franked and the corporate tax rate was effectively constant. We explain in Section 5 that this leads to near perfect collinearity in the two independent variables in which case it is difficult to separately interpret the value of tax credits and the value of cash dividends.

Hathaway and Officer (2002) use a similar methodology to estimate the value of cash dividends and franking credits for various subsets of the available data. They report that cash dividends are much more valuable than franking credits for small industrial firms, but that the reverse is true for small resource firms. Also, franking credits are estimated to be three times more valuable for large industrials than for small industrials. These results highlight the difficulty of separately valuing cash dividends and franking credits due to the close relationship between the two.

The early empirical research into the value of tax credits suffers from two problems. The first is that noise in security prices causes the sampling error of the estimates from ex-dividend date studies to be considerable, even with large sample sizes. For example, the 95% confidence interval for the estimated value of one dollar of imputation tax credits reported in Brown and Clarke (1993) is -12.44 cents to +24.52 cents over the period 1 July 1987 to 30 June 1989 and +38.46 cents to +103.68 cents for the period 1 July 1989 to 30 June 1991, using respective sample sizes of 801 and 851 observations. Expressing these values as a percentage of the estimated value of the cash dividend over the respective periods, the estimated value of the tax credits is 11.8% in the first period and 79.6% in the second period. They suggest (p. 34) that a possible explanation for the large difference in the results between the two periods: "The marked increase in the value of the franking variable in the later period might reflect a greater ability of the market, on average, to access the value of tax credits". An alternate explanation is an increase in multicollinearity in the second period. This potential multicollinearity problem, and methods for dealing with it, are described in Section 5.

The second problem is that the value of tax credits is measured together with the value of dividends to which they attach. Separating the value of the tax credits requires estimating the capitalized value of dividends extracted from data for companies with less than 100% franking. These estimates themselves are subject to considerable sampling error. Moreover, the implicit assumption made is that the capitalized value of dividends is independent of the degree of franking. If clienteles form on the basis of franking credits or other variables correlated with the degree of franking adopted by companies, then this assumption may not be valid. Bellamy (1994) provides evidence strongly supporting the existence of clienteles related the imputation policies of listed companies.

3. Empirical Methods Used in the Literature

In this section we describe the range of empirical methods that have been used in prior research. The first part of the discussion examines methods used to estimate the value of cash dividends relative to capital gains. This evidence comes from classical tax systems such as the U.S. and pre-imputation Australia. This is followed by a discussion of methods used to estimate the value of tax credits in a dividend imputation system.

3.1. Cash Dividends

The classical dividend drop-off literature seeks to estimate the effect that the payment of the dividend has on the stock price. It is most common to define $P_{i,t-1}$ to be the cum-dividend price (usually the closing price) and $P_{i,t}$ to be the ex-dividend price (either an opening price or a closing price on the ex-dividend day) for dividend event i; $i=1,...N$. The dividend drop-off for event i is usually measured as:

$$\delta_i = \frac{P_{i,t-1} - P_{i,t}}{D_i}. \tag{1}$$

Attempts have also been made to control for expected returns on the stock – some movement in the stock price might be expected for reasons other than the dividend payment. The literature has used three methods to estimate the expected return on the stock over the ex-dividend event, $Er_{i,t}$. These methods are summarized by Michaely (1991). The simplest measure of expected returns is the mean return from some out-of-event period. Michaely suggests using the period [t-25, t-2] and [t+2, t+25] relative to ex-date t. This approach has the benefit of simplicity, but it does not account for market movements. If, for example, the market was sharply down on the ex-date t, a decline in the stock price might be expected for reasons other than the dividend.

An alternative, therefore, is to use the market model (CAPM) to estimate expected returns. This is usually implemented by regressing stock returns on market returns over an out-of-event period. For each dividend event, $Er_{i,t} = \alpha_i + \beta_i r_{m,t}$ where α_i and β_i are coefficients estimated using least squares. Due to (i) measurement issues in estimating individual stock betas and (ii) the short period of time between t-1 and t, it is most common to use a zero-one adjustment, where $\alpha_i = 0$ and $\beta_i = 1$ for all dividend events. This results in the observed market return being used as a proxy for the expected return of the stock[2].

However the expected return is estimated, the adjusted drop-off is measured as:

$$\delta_i^* = \frac{P_{i,t-1}\left(1 + Er_{i,t}\right) - P_{i,t}}{D_i}$$

[2] Brown and Warner (1985) recommend the zero-one adjusted model over the market-adjusted returns model, particularly, in the case of event-day clustering and seasonality in the market abnormal returns. Shevlin (1981) confirms that the zero-one model performs as well as, if not better than, market and cross-sectional models in event study tests using Australian data.

(2)

where $Er_{i,t}$ is the expected return on stock i for the interval $t-1$ to t.

Having obtained a measure of the drop-off for each dividend event, a system of summarizing or averaging must be employed. Ideally, this could be done on a company-by-company basis to provide insights into the relative value of dividends to shareholders of a particular firm. However, only two observations per firm are generated each year in Australia (and only four in the U.S.) so aggregation across firms is required to obtain reasonable sample sizes.

Following Elton and Gruber (1970), the most common form of aggregation is simply the mean drop-off across all observations in the sample:

$$\delta = E\left[\delta_i\right] = \frac{1}{N}\sum_{i=1}^{N}\delta_i = \frac{1}{N}\sum_{i=1}^{N}\frac{P_{i,t-1}-P_{i,t}}{D_i}. \tag{3}$$

This is equivalent to an ordinary least squares regression of measured drop-offs on a constant:

$$\delta_i = \overline{\delta} + \nu_i. \tag{4}$$

Inference is normally conducted in the standard way, assuming that $\nu_i \sim N\left(0,\sigma^2\right)$ for all i=1,…,N. However, Lakonishok and Vermaelen (1983) and Michaely (1991) note that the assumption of a constant variance for all ν_i is likely to be invalid. In particular, Michaely develops a model in which the return over the ex-day is equal to an expected return plus noise:

$$\begin{aligned} r_{i,t} &= Er_{i,t} + \varepsilon_{i,t} \\ \varepsilon_{i,t} &\sim N\left(0,\sigma_i^2\right). \end{aligned} \tag{5}$$

Michaely estimates the expected return and the variance of the residuals using data from days (t-25, t-2) and (t+2, t+25) relative to the ex-date t.

Expressing this return relation in terms of prices yields:

$$\frac{P_{i,t}-P_{i,t-1}}{P_{i,t-1}}=\frac{E\left(P_{i,t}\right)-P_{i,t-1}}{P_{i,t-1}}+\varepsilon_{i,t.} \tag{6}$$

Once again, the objective is to construct an estimate of:

$$\delta=E\left[\delta_i\right]=\frac{P_{i,t-1}-E\left(P_{i,t}\right)}{D_i}. \tag{7}$$

Dividing numerator and denominator by $P_{i,t-1}$ and using Equation (6) and the definition of δ_i yields:

$$\delta_i=\overline{\delta}-\varepsilon_{i,t}\frac{P_{i,t-1}}{D_i}. \tag{8}$$

That is, the disturbances are heteroscedastic. If we define $\nu_i=-\varepsilon_{i,t}\frac{P_{i,t-1}}{D_i}$, then $\nu_i \sim N\left(0,\frac{\sigma_i^2}{d_i^2}\right)$ where d_i is the dividend yield for event *i*. In this setting, Ordinary Least Squares Regression (OLS) is inappropriate—more efficient estimates can be obtained via Generalized Least Squares (GLS). This involves weighting each observation by the inverse of the variance of the disturbances d_i^2/σ_i^2. That is, observations with high dividend yield and low return variance receive greater weight. When a volatile stock pays a small dividend, the drop-off can be several orders of magnitude grater than the dividend, in either direction. We learn little from this observation as the dividend is only a small component of the stock price movement. In a GLS setting, such observations are down-weighted whereas OLS gives equal weight to all observations.

An alternative specification is obtained by multiplying Equation (7) by the inverse of the dividend yield:

$$\frac{P_{i,t-1}-P_{i,t}}{P_{i,t-1}}=\delta\frac{D_i}{P_{i,t-1}}-\varepsilon_{i,t}. \tag{9}$$

In this case the disturbance does not depend on dividend yield—recall that $\varepsilon_{i,t} \sim N\left(0,\sigma_i^2\right)$. However GLS is still appropriate due to the heteroscedasticity of the residuals—observations should be weighted by the inverse of the return variance.

In summary, (i) the ex-day price change can be raw or adjusted for expected return, (ii) the dependent variable can be defined as the drop-off ratio or the stock return, and (iii) estimation can be by OLS or GLS. There are, therefore, eight possible combinations and these are summarized in Table 1.

[TABLE 1 ABOUT HERE]

3.2. Tax Credits

In a dividend imputation tax system, tax (or franking) credits may be attached to a dividend payment. In this case, there are two potential sources of value—the cash dividend and the franking credit. Each of these may have a different value and both might be reflected in the dividend drop-off. To account for this, the methodologies that are surveyed in the previous section can be augmented to account for the potential value of franking credits.

In a full imputation system such as Australia, the amount of franking credits attached to a dividend is:

$$FC_i = D_i \frac{\tau_c}{1-\tau_c} f_i \tag{10}$$

where D_i is the dividend amount, $0 \le f_i \le 1$ is the franking percentage, and τ_i is the corporate tax rate applied to profits out of which the dividend is paid.

Thus, the regression in Equation 4, on which Methods 1 and 2 in Table 1 are based, is augmented as follows:

$$\delta_i = \overline{\delta} + \overline{\phi} \frac{FC_i}{D_i} + \nu_i \tag{11}$$

where ϕ represents the average value of a dollar of franking credits distributed to shareholders.

Methods 3 and 4 in Table 1 differ from this only to the extent that the drop-off is adjusted for expected returns (i.e., δ_i^* replaces δ_i).

Methods 5 and 6 in Table 1 are augmented to take the following form:

$$r_i = \delta\, d_i + \phi \frac{FC_i}{P_{i,t-1}} + \varepsilon_i, \tag{12}$$

and Methods 7 and 8 use adjusted returns as the dependent variable.

These eight possible methodologies are summarised in Table 2.

[TABLE 2 ABOUT HERE]

3.3. Sample Screening

Once a decision has been made on which econometric specification to use, a range of sample selection issues must be addressed.

Large Drop-offs and Non-Dividend Events

Some researchers screen out observations for which the drop-off is large in magnitude. The rationale for this is that there must be a significant event, unrelated to the dividend, that caused such a disproportionately large change in the stock price. A range of screening techniques has been observed in the literature. Bruckner, Dews, and White (1994) and Hathaway and Officer (1992), for example, exclude all drop-offs that are larger in magnitude.

Non-Trading

If the sample includes smaller stocks, illiquidity and non-trading is a potential problem. For example, a stock may trade two days before the ex-date and again two days after, with no trades in

between. In this case, the drop-off is measured over a period of several days, which adds noise to the estimation process. The tradeoff is that restricting the sample to those stocks that trade both on the cum-and ex-dividend dates would bias the sample toward large, liquid stocks. This tradeoff is usually managed by imposing a trading period some days before and after the ex-date. Note that GLS estimates accommodate non-trading by recognizing the increased measurement error (or noise) and assigning such observations lower weight.

Zero Drop-Offs

In a number of papers, zero drop-offs are eliminated from the sample. These are observations for which trades do occur within the required period before and after the ex-date, but where the cum- and ex-dividend prices are the same. Examples of papers that exclude zero drop-offs include Bruckner, Dews, and White (1994) and Hathaway and Officer (1992). These papers include drop-offs of ±0.1% but exclude zero drop-offs, even though these are all based on traded prices. The effect of this exclusion is to increase the estimated drop-off.

4. Data and Simulation Evidence

To examine the effectiveness of the various empirical techniques, we apply them to data that is simulated to match the empirical characteristics of the Australian data that we analyse in detail in Section 5.

4.1. Data

We obtained data on all dividends paid on ordinary shares listed on the ASX as well as daily prices and trading volumes for the 90 days either side of the ex-date. Our sample period is from March 14, 1995 to November 29, 2002. We exclude any dividend that occurs within one month of a capitalisation change. The final sample consists of 5640 dividend events.

For each dividend event, we compute a number of characteristics such as dividend yield, franking level, firm size, trading frequency, and volatility. The latter two characteristics are computed with reference to an out-of-sample period: trading days –90 to –31 and +31 to +90, relative to the ex-date. These characteristics are summarised in Table 5.

[TABLE 3 HERE]

To record trading frequency, we measure the number of days on which a trade occurs, and express this as a proportion of the 120 possible trading days. This is interpreted as the probability of a trade occurring on any particular day.

Volatility is measured as the standard deviation of daily returns over the 120-day out-of-event window, with adjustments for non-trading. If adjacent trades are five days apart, for example, we treat this five-day period as a single observation. This is done by squaring the difference between the actual five-day return and five times the expected one-day return. If a stock traded on less than ten days in the out-of-event window, we used the median of the volatilities of all traded stocks. Some summary statistics are reported in Table 3.

4.2. Simulation Procedure

We generate 1,000 samples, each of 1,000 ex-dividend events. For each event, we begin by drawing the characteristics of the stock and its dividend from our empirical sample. To do this, we randomly sample 1,000 of our sample of 5640 dividend events. For each event in our sample, we observe the dividend yield (d_i) and cum-dividend stock price $\left(P_{i,t-1}\right)$. The dividend amount is the product of the dividend yield and the cum-dividend stock price, $D_i = d_i\ P_{i,t-1}$. We then observe the franking level $\left(0 \le f_i \le 1\right)$ for that observation and the corporate tax rate at the relevant time $\left(\tau_i\right)$. Thus, the franking credits attached to dividend *i* are:

$$FC_i = D_i\ f_i \frac{\tau_i}{1-\tau_i}. \tag{13}$$

Next, we compute the actual market return for each of the 50 days before and after the dividend ex-date. We define the observed market return on the day to be the expected return on the stock $\left(Er_{i,t}\right)$ for each day over the ex-dividend event, where $-50 \le t \le 50$. The implicit assumption is that all stocks have a beta of 1 $\left(\beta_i = 1 \text{ for all } i\right)$ and zero abnormal performance $\left(\alpha_i = 1 \text{ for all } i\right)$. This zero-one market model is discussed in more detail in Section 3. Finally, we record the size of the

company and its trading frequency which is measured as the proportion of available trading days on which the stock actually trades.

To summarize, for each randomly selected dividend event, we record all of the relevant event characteristics. This includes cum-dividend stock price $\left(P_{i,t-1}\right)$, dividend yield $\left(d_i\right)$, franking level $\left(f_i\right)$, corporate tax rate $\left(\tau_i\right)$, firm size $\left(S_i\right)$, trading frequency $\left(\lambda_i\right)$, expected return for the 50 days before and after the ex-date $\left(Er_{i,t}; t = 50,\ldots 50\right)$, and volatility $\left(\sigma_i\right)$.

For each event, we simulate a series of stock prices for 50 days before and 50 days after the ex-dividend date. The stock return for each day is generated as:

$$\begin{aligned} r_{i,t} &= Er_i + \varepsilon_{i,t} \\ \varepsilon_{i,t} &\sim N\left(0, \sigma_i\right). \end{aligned} \tag{14}$$

We begin our simulation with the cum-dividend stock price. Then prices are generated so that $P_{i,t-49} = P_{i,t-50}\left(1 + r_{i,t-49}\right)$, and so on.

The price on the ex-dividend date is generated as:

$$P_{i,t} = P_{i,t-1}\left(1 + r_{i,t}\right) - \delta\, D_i - \phi\, FC_i, \tag{15}$$

where δ represents the value of cash dividends and ϕ represents the value of distributed franking credits. Both of these are held constant across all events throughout the simulation exercise.

Of course, not all stocks trade every day. To capture this, we set the probability of a trade occurring on a particular day equal to the stock's trading frequency measure, λ_i. Then if a small company does not trade for *s* days, for example, we have:

$$\begin{aligned} r_{i,t,t+s} &= s\ \ Er_i + \varepsilon_{i,t,t+s} \\ \varepsilon_{i,t,t+s} &\sim N\left(0, \sqrt{s}\ \sigma_i\right). \end{aligned} \tag{16}$$

and we will not have a price observation for *s* days.

The result of our simulation procedure so far, is for each ex-dividend event, a series of up to 100 stock price observations around the ex-date. This is similar to the type of data available to researchers. From these data we implement the range of empirical techniques and sample screening rules that have been used in the literature to date.

4.3. Simulation Results

In our simulation exercise, we set $\delta = 1$ and $\phi = o$. That is, for all of our simulated observations, cash dividends are fully valued, and distributed franking credits are worthless to the ex-date price-setting investor.

We generated 1,000 samples, each consisting of 1,000 dividend events randomly selected from our data set. For each sample, we applied the eight econometric methods that are documented in Table 1. Thus, for each method we have 1,000 estimates of the value of cash dividends (δ) and 1,000 estimates of the value of distributed franking credits (ϕ). We report the mean, median, and some distributional statistics in Table 4.

[TABLE 4 HERE]

The results clearly demonstrate the importance of adjusting for expected return and weighting by dividend yield and the inverse of volatility. Method 1, which makes none of these adjustments, produces a mean estimate of 74% and 15% for cash dividends and franking credits respectively, even when we know the data have been generated such that these values are 100% and 0%. Moreover, the standard deviation and range of the 1,000 parameter estimates is very large. The 90% confidence interval for both cash dividends and franking credits contains both 0 and 1. For some samples dividends are estimated to be worth more than their face value and for other samples they are estimated to have negative value. The same result holds for franking credits. Clearly, the results of papers that use this standard methodology must be interpreted with the greatest caution.

By contrast, Methods 4 and 8 make adjustments for expected return and place more weight on more informative observations (those with low volatility and high dividend yield). Note that those methods produce the same results as they are equivalent, For Method 4 we have:

$$\begin{aligned} \delta_i^* &= \delta + \nu_i \\ \nu_i &\sim N\left(0, \frac{\sigma_i^2}{d_i^2}\right) \end{aligned} \tag{17}$$

Multiplying all terms by the dividend yield gives:

$$\begin{aligned} \delta_i^* \, d_i = r_i^* &= \delta \, d_i + \nu_i d_i \\ \nu_i d_i &\sim N\left(0, \sigma_i^2\right), \end{aligned} \tag{18}$$

which is Method 8. Thus, the same coefficient estimates will be generated by both methods.

For Methods 4 and 8, the mean parameter estimates are very close to their true values and the standard deviations are low relative to all other techniques. There are few samples for which the estimate of the value of cash dividends is outside the range [0.90, 1.10]. The value of distributed franking credits is not estimated quite so precisely, with the 90% confidence interval being in the order of [-0.20, 0.20].

The conclusion to be drawn from this analysis is that the choice of econometric technique is of crucial importance in dividend drop-off analysis. In our simulation analysis, we preserve the characteristics of dividend events from real data, but fix the value of dividends and franking credits to be the same for all observations. A range of econometric techniques are examined in terms of their ability to recover these known values. The results clearly demonstrate the need to adjust for the expected return of the stock over the ex-dividend period and to weight by the informativeness of the observation $\left(d_i^2 / \sigma_i^2\right)$.

The next step in our analysis is to examine the effects of different sample screening techniques. Following the literature discussed in Section 3, we examine screens that involve excluding all observations for which the drop-off is more than five times the magnitude of the dividend, all observations for which the stock does not trade for more than five days around the ex-date, and all

observations for which the drop-off is zero. In our simulation analysis, all stock prices are rounded to the nearest cent, making it possible to observe a drop-off of exactly zero. We also examine the results for various sub-samples: fully franked versus unfranked dividends, and big versus small firms. In all cases, our simulation procedure remains the same—we form a sample of 1,000 observations, drawing the key characteristics from our data set, then imposing $\delta = 1$ and $\phi = 0$ in our simulation. The results of this analysis appear in Table 5.

[TABLE 5 HERE]

Table 5 illustrates that application of screening procedures have a much greater effect on some empirical methods than on others. The performance of Method 1, which amounts to the simple mean of the conventionally-defined drop-off, shows the greatest change in performance. This method gives equal weight to all observations and is therefore more influenced by outliers than other methods. For example, it is not uncommon for a 50-cent stock that pays a half-cent dividend to see its price change by more than five cents on the ex-day, giving a drop-off magnitude of ten, These sorts of outliers can have a significant impact on the results, which is manifested in very wide confidence intervals when Method 1 is applied to the unscreened sample. When these outliers are screened out (column B), the confidence intervals narrow substantially—from a range of 1.8 to 0.4 for δ, and from a range of 3.4 to 0.9 for a ϕ. On average, this screening procedure eliminates about 25% of the sample.

At the other extreme, the screening procedure has almost no impact on the performance of Method 8. This is because observations that are likely to be screened out are already given low weight. Large drop-off magnitudes are associated with low dividend yields and non-trading stocks are likely to exhibit higher volatility. Method 8 weights by dividend yield and the inverse of volatility already, so these uninformative noise-creating observations are essentially screened out already.

When the sample is restricted to franked dividends (Column C), confidence intervals widen considerably for all methods. This is due to the multicollinearity problem that is discussed in Section 3 and further explored in Section 5. When the sample is restricted to fully franked dividends, there is near perfect collinearity between cash dividends and franking credits. Although

the value of the sum can be reliably estimated, individual coefficients cannot—hence the wide range of particular estimates.

Columns D and E examine samples based on firm size. While only 15% of observations are screened out for big firms, 35% of small firm observations are eliminated by standard screening procedures. This is primarily because small firms trade less frequently. Small firms also tend to have lower prices and are therefore more likely to exhibit a zero drop-off. This causes an upward bias in the estimate of the value of cash dividends.

In summary, the empirical methodology and sample screening techniques that are employed can have a significant impact on estimates of the value of cash dividends and associated tax credits. Methods that adjust for market returns and give more weight to observations with high dividend yield and low volatility are the most stable and robust. For this reason, we focus on Method 8 in the analysis of our empirical data set.

5. Empirical Results

Having established the importance of econometric methodology and sample screening procedures, we turn to our full data set. Key features of the data are documented in Section 4.1 and Table 3.

5.1. Raw Results

Table 6 contains parameter estimates from all eight econometric methods applied to the full data set and various sub-samples. No screening for non-trading, large drop-offs or zero drop-offs is performed.

[TABLE 6 HERE]

Since we have already established that Method 8 is the most robust when applied to an unscreened sample, we concentrate on the last rows of Table 6. In the full sample, Method 8 suggests that cash dividends and franking credits are valued at around 83% and 36% of their face value, respectively.

The low value of cash dividends is curious, given the vast array of international research that finds that a 100% value of cash dividends has been "a good rule of thumb for the last 25 years."

Even more curious is the behaviour of these estimates for constrained samples. Consider, for example, the post 45-day rule sample. Australian tax laws allow resident tax-payers to use franking credits to offset personal tax obligations. Non-resident investors cannot use franking credits. This led to a range of tax arbitrage strategies that effectively allowed the transfer of franking credits from non-residents to residents. A package of measures designed to prevent short-term trading in dividends and the associated imputation credits was announced in the delivery of the 1997-98 Federal budget and were deemed to be effective from 1 July 1997. The significant strengthening of the laws relating to imputation tax credits chiefly concerned the imposition of a 45-day minimum holding period. Unless a stock is held for forty-five days around the date of dividend entitlement, investors do not qualify for franking credits. In determining whether stocks are held for the requisite holding period, days during which there is in place a risk diminution arrangement are not counted. Consequently, if a shareholder attempts to substantially hedge the holding period risk via derivative securities, the franking credits are disallowed.

The introduction of this 45-day rule will have affected the market value of imputation credits if (1) the schemes in place were effective, having a material effect on the proportion of imputation credits that were utilized, and (2) the new rule effectively eliminates those schemes or increases the cost of operating them. For this reason, we examine a sub-sample of our data subsequent to the introduction of the 45-day rule. The results suggest that the value of franking credits has *increased* since the 45-day rule. Moreover, this increase is concentrated in *large* firms. Intuition would suggest the opposite. Large firms are more likely to have significant foreign ownership, for whom the 45-day rule is most costly.

Applying various sample screening procedures to Method 8 makes little difference to these results as this method already effectively downweights observations with low dividend yield and high volatility. Table 7 reports results for various samples and cumulative screening procedures. That is, the second panel imposes a non-trading screen, the third panel adds the maximum drop-off screen and so on.

[TABLE 7 HERE]

5.2. Multicollinearity

The low value of cash dividends and the increase in the estimated value of franking credits after the 45-day rule are likely to be driven by multicollinearity between dividends and franking credits. To see the effects of multicollinearity in Tables 6 and 7 note that for each method and each subset of the data, we have estimates of δ and ϕ. In those cells where the estimate of δ is high (close to 1) the estimate of ϕ is low (close to zero). But where the estimate of δ is lower, the estimate of ϕ is higher. This is at least consistent with positive correlation between our two independent variables. Of course since the amount of franking credits is computed by multiplying the dividend by $\frac{\tau_c}{1-\tau_c}$, perfect collinearity is only prevented by changes in the corporate tax rate or the payment of unfranked or partially-franked dividends. Unfortunately, changes in corporate tax rates in our sample have been small, partially-franked dividends are rare, are unfranked dividends tend to be small and infrequent relative to fully franked dividends. Indeed the correlation between cash dividends and franking credits in our full sample is 0.85. Thus, multicollinearity remains a problem for our sample.

To illustrate the potential effects of multicollinearity, we plot the estimates of δ and ϕ from our main simulation. When we apply Method 8 to simulated samples drawn from the full data set, we obtain 1,000 estimates of δ and ϕ—one for each simulated sample. These estimates form the basis of the last rows of Table 3. Those 1,000 δ – ϕ pairs are plotted in Figure 1. The results present a clear picture of multicollinearity. When the value of dividends is underestimated (δ < 1) the value of franking credits is overestimated (ϕ > 0) to "take up the slack", and vice versa. This result implies that it is difficult to separately interpret estimates of δ and ϕ. It also suggests, however, that the value of grossed-up dividends (the sum of cash dividends and franking credits) *can* be reliably estimated. To examine this, we compute the value of grossed-up dividends for each of our 1,000 simulations as $\delta + \phi\frac{0.36}{1-0.36}$, where 36% is the applicable tax rate for the majority of our sample. Even though there is considerable variation in our estimates of individual parameters (0.80 < δ < 1.22; -0.35 < ϕ < 0.37), there are only 19 of our 1,000 simulations for which the value of

grossed-up dividends is outside of the range [0.95, 1.05]. Thus, although individual coefficients are difficult to estimate, the value of the package of dividends and franking credits can be reliably estimated. Of course this implies that if we have a reliable estimate of one component, we can reliably estimate the other.

[FIGURE 1 HERE]

To explore this further, we return to our actual data set and fix the value of each cash dividend at 100%. This is based on a wealth of evidence from other markets (see Michaely, 1991; Barone-Adesi and Whaley, 1986; and Boyd and Jagannathan, 1994). Having fixed the value of dividends at 100%, we then proceed to estimate ϕ, the value of franking credits. This amounts to repeating the last rows of Table 7 after setting $\delta = 1$. The results, which are reported in Table 8, give a very clear picture. In all cases, the estimated value of franking credits is within 10% of zero, and statistical significance is only reached for the single subsample of large firms. We also test the statistical significance of the unconstrained model (where δ and ϕ are separately estimated) against the constrained model (where δ is set to 1). The resulting F-statistics and P-values confirm that a model in which cash dividends are fully valued and franking credits have economically small values cannot be statistically rejected against the unconstrained model. We examine a further constrained model in which cash dividends are fully valued and franking credits are worthless ($\delta = 1$, $\phi = 0$). This constrained model also cannot be statistically rejected against the unconstrained model. That is, the data are unable to reject the hypothesis that cash dividends are fully valued and franking credits are worthless to the marginal ex-dividend investor. To further explore the economic implications of this result, we measure the value of the package of dividend plus franking credits as $\delta D_i + \phi D_i f_i\left(\frac{\tau_i}{1-\tau_i}\right)$, where δ and ϕ are estimated using the full sample and Method 8. We then regress this package valued on the cash dividend itself, D_i. The results in Table 8 indicate that the estimated value of the package is indistinguishable from the cash dividend. That is, to determine the value of the package, we need only know the amount of the dividend. The value of the package is essentially independent of the amount of franking credits. This is also consistent with cash dividends being fully valued and franking credits being worthless to the marginal price-setting investor.

Moreover, these results are all consistent with Hathaway and Officer (2002) who use the ex-dividend date stock price decline to separately estimate the value of a dollar of dividends and a dollar of franking credits for different types of companies. Their results are reproduced in Table 9 Panel A. The most striking result is the lack of consistency across cells. Resource and industrial stocks seem to behave quite differently and small vs. large resource stocks differ considerably. For small resource stocks, the results suggest that, for the average firm, the marginal ex-date investor values a dollar of franking credits considerably more than a dollar of cash dividends. This seems unlikely—it is difficult to imagine any circumstance in which an investor would prefer franking credits to dividends. To examine whether multicollinearity is driving these results, we can examine the value of the package of dividend plus franking credit. This is done in Panel B of Table 9. This Panel takes the estimates from Hathaway and Officer (2002) and converts them into a single estimate of the package of dividends and franking credits. The results are remarkably consistent—in every cell, the total value of the package is around one. This indicates that the separate values of dividends and franking credits are likely to be affected by the statistical problem of multicollinearity—the wide variation across cells is more likely to be caused by statistical estimation issues than fundamental economic differences. The total value of the package, which is unaffected by these statistical problems, is likely to be reliably estimated, and is remarkably consistent across cells. These results can therefore be interpreted as consistent with dividends being fully valued and franking credits being worthless to the marginal price-setting investor.

[TABLE 9 HERE]

5.3. Robustness Checks

The results thus far are consistent with the conclusion that cash dividends are fully valued and franking credits are worthless to the marginal ex-date investor. We further explore this interpretation via two additional robustness checks.

First, we have already established that the value of the package of dividends plus franking credits is approximately equal to 100% of the value of the cash dividend in both our sample and the sub-samples examined by Hathaway and Officer (2002). This is consistent with cash dividends being fully valued and franking credits being worthless. It is, however, also consistent with cash

dividends being worth less than their face value and franking credits being worth a portion of their face value. To separate these interpretations, we separately examine periods of different corporate tax rates. As tax rates change, the value of franking credits relative to cash dividends changes. A fully-franked dividend generates a franking credit of $\tau/(1-\tau)$ for every dollar of dividends, where τ is the corporate tax rate applied to the profits out of which the dividend was paid. Thus, if franking credits are valued, the package of dividend plus franking credit will vary with the corporate tax rate. Changes in the tax rate cause changes in the amount of franking credits and would then cause a change in the value of the package. If, however, franking credits are worthless and cash dividends are fully valued, the value of this package would be equal to 100% of the value of the cash dividend regardless of the corporate tax rate. In our sample, there are 4,173 observations for which the corporate tax rate is 36%. For that sub-sample, we estimate the value of the package of dividends and franking credits to be equal to 103% of the value of cash dividends. For the 734 observations with τ = 34%, the value of the package is 101% of the value of cash dividends. And for the 733 observations with τ = 30%, the value of the package is 99.6% of the value of cash dividends. There is remarkable consistency across these various sub-samples, consistent with cash dividends being fully valued and franking credits being worthless.

Second, we examine the effect of a small number of influential observations on our raw results. Method 8 applied to our full sample yields estimates of δ = 0.832 and ϕ = 0.359. To further examine the lack of robustness in this estimate of the value of franking credits, ϕ, we explore the effect of the most influential observations. To do this, we determine which of our 5,640 observations, if removed, would reduce the estimate of ϕ by the greatest amount. Then we do the same for the remaining 5,639 observations, and so on. The estimate of ϕ in the full sample is ϕ = 0.359. If 5 influential observations are removed, the estimate falls to ϕ = 0.27. When 10 influential observations are removed, we estimate ϕ = 0.21. Removal of 35 observations yields ϕ = 0.05 and removal of 45 observations yields ϕ = 0.00. Thus, removal of well below 1% of the sample observations reduces the estimate of the value of franking credits to zero. Of course we are not suggesting that these observations be simply deleted as outliers. Our point here is to demonstrate the instability of this estimate. If we can remove a few observations and eliminate the value of franking credits, how confident can we be that they are valuable in the first place?

If the package of dividends and franking credits has a value of 1.00 relative to the dividend, this means that the stock price drops, on average, by the amount of the dividend. All of this evidence implies that if cash dividends in Australia are fully valued, as other evidence suggests and our robustness checks suggest is the case, franking credits are worthless to the marginal investors trading around dividend ex-dates. At a minimum, we can state that the available data cannot reject the hypothesis that cash dividends are fully valued and that franking credits are worthless to the marginal trader around dividend ex-dates.

6. Conclusions

The change in share prices around ex-dividend dates is frequently used to estimate the value of cash dividends and imputation franking credits. We show that the estimates from this procedure are *highly* sensitive to the choice of econometric method and to sample selection issues. Our simulation exercises indicate that the most robust econometric approach is one that allows for expected returns over the ex-dividend period and weights observations according to their informativeness—more weight being given to high dividend yields and less to highly volatile stocks. Application of this technique to Australian data suggests that it is difficult to separately estimate the values of cash dividends and franking credits. If cash dividends are assumed to be fully valued (as they are in other markets and as our robustness checks suggest) the data suggests that franking credits are worthless to the marginal trader around the ex-date. The available data cannot be used to reject the hypothesis that cash dividends are fully valued and that franking credits are worthless to the marginal ex-date investor.

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Table 1
Dividend Drop-off Methodologies—Classical Tax System.

Method	Dependent Variable	Independent Variable	Estimation Technique	Weighting
1.	δ_i	Constant	OLS	$1/N$
2.	δ_i	Constant	GLS	$\frac{d_i^2}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{d_i^2}{\sigma_i^2}$
3.	δ_i^*	Constant	OLS	$1/N$
4.	δ_i^*	Constant	GLS	$\frac{d_i^2}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{d_i^2}{\sigma_i^2}$
5.	r_i	d_i	OLS	$1/N$
6.	r_i	d_i	GLS	$\frac{1}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{1}{\sigma_i^2}$
7.	r_i^*	d_i	OLS	$1/N$
8.	r_i^*	d_i	GLS	$\frac{1}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{1}{\sigma_i^2}$

$\delta_i = \frac{P_{i,t-1} - P_{i,t}}{D_i}$; $\delta_i^* = \frac{P_{i,t-1}\left(1 + Er_{i,t}\right) - P_{i,t}}{D_i}$ where $Er_{i,t}$ is the expected return on stock i over day t; $r_i = \frac{P_{i,t-1} - P_{i,t}}{P_{i,t-1}}$, $r_i^* = \frac{P_{i,t-1}\left(1 + Er_{i,t}\right) - P_{i-t}}{P_{i,t-1}}$, $d_i = \frac{D_i}{P_{i,t-1}}$.

In all cases, the model is: $\begin{bmatrix}\text{Dependent} \\ \text{Variable}\end{bmatrix} = \bar{\delta}\begin{bmatrix}\text{Independent} \\ \text{Variable}\end{bmatrix} + \nu_i$, and $\bar{\delta}$ is the coefficient to be estimated.

Table 2
Dividend Drop-off Methodologies—Dividend Imputation Tax System.

Method	Dependent Variable	Independent Variables	Estimation Technique	Weighting
1.	δ_i	Constant, FC_i/D_i	OLS	$1/N$
2.	δ_i	Constant, FC_i/D_i	GLS	$\frac{d_i^2}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{d_i^2}{\sigma_i^2}$
3.	δ_i^*	Constant, FC_i/D_i	OLS	$1/N$
4.	δ_i^*	Constant, FC_i/D_i	GLS	$\frac{d_i^2}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{d_i^2}{\sigma_i^2}$
5.	r_i	d_i, $FC_i/P_{i,t-1}$	OLS	$1/N$
6.	r_i	d_i, $FC_i/P_{i,t-1}$	GLS	$\frac{1}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{1}{\sigma_i^2}$
7.	r_i^*	d_i, $FC_i/P_{i,t-1}$	OLS	$1/N$
8.	r_i^*	d_i, $FC_i/P_{i,t-1}$	GLS	$\frac{1}{\sigma_i^2} \Big/ \sum_{i=1}^{N} \frac{1}{\sigma_i^2}$

$\delta_i = \frac{P_{i,t-1} - P_{i,t}}{D_i}$; $\delta_i^* = \frac{P_{i,t-1}\left(1+Er_{i,t}\right) - P_{i,t}}{D_i}$ where $Er_{i,t}$ is the expected return on stock i over day t; $r_i = \frac{P_{i,t-1} - P_{i,t}}{P_{i,t-1}}$, $r_i^* = \frac{P_{i,t-1}\left(1+Er_{i,t}\right) - P_{i,t}}{P_{i,t-1}}$, $d_i = \frac{D_i}{P_{i,t-1}}$.

In all cases, the model is: $\begin{bmatrix}\text{Dependent}\\ \text{Variable}\end{bmatrix} = \bar{\delta}\begin{bmatrix}\text{Independent}\\ \text{Variable \#1}\end{bmatrix} + \bar{\phi}\begin{bmatrix}\text{Independent}\\ \text{Variable \#2}\end{bmatrix} + \nu_i$, and $\bar{\delta}$ and $\bar{\phi}$ are the coefficients to be estimated.

Table 3
Summary Statistics.

Panel A						
Number of Observations	5640					
Number Fully-franked	4347					
Number Partially-franked	405					
Number Un-franked	888					
Panel B						
	Mean	**Percentiles**				
		5	**25**	**50**	**75**	**95**
Dividend Yield (%)	2.85	0.81	1.72	2.44	3.40	5.75
Firm Size ($m)	1193.2	9.1	36.7	124.2	546.1	5117.2
σ (daily) (%)	2.22%	1.02%	1.50%	1.93%	2.60%	4.35%
Trading Frequency (days)	2.39	1	1	2	2	6

Data on all dividends paid on ordinary shares on the ASX from March 14, 1995 to November 29, 2002 was obtained from SIRCA.

Table 4
Results of Simulation Analysis

Method	Parameter	Mean Estimate A	Standard Deviation of Estimates B	Median Estimate C	90% Confidence Interval D	Proportion Outside ±0.1 of True Value E
1	δ	0.909	0.576	0.921	[0.035, 1.847]	482, 333
	ϕ	0.036	1.073	0.014	[-1.706, 1.686]	445, 453
2	δ	0.982	0.106	0.985	[0.819, 1.142]	181, 98
	ϕ	-0.072	0.241	-0.047	[-0.494, 0.246]	398, 210
3	δ	0.986	0.567	0.997	[0.110, 1.878]	427, 392
	ϕ	0.030	1.056	0.007	[-1.631, 1.601]	444, 462
4	δ	0.999	0.065	0.999	[0.891, 1.107]	67, 63
	ϕ	0.004	0.126	0.007	[-0.210, 0.212]	206, 228
5	δ	0.965	0.157	0.968	[0.719, 1.214]	322, 187
	ϕ	-0.010	0.309	-0.006	[-0.500, 0.502]	373, 354
6	δ	0.982	0.106	0.985	[0.819, 1.142]	181, 98
	ϕ	-0.072	0.241	-0.047	[-0.494, 0.246]	398, 210
7	δ	1.003	0.154	1.003	[0.746, 1.244]	255, 262
	ϕ	-0.002	0.303	0.003	[-0.494, 0.499]	362, 367
8	δ	0.999	0.065	0.999	[0.891, 1.107]	67, 63
	ϕ	0.004	0.126	0.007	[-0.210, 0.212]	206, 228

Econometric methods 1-8 are defined in Table 2. The simulation procedure is defined in Section 5.1. δ is an estimate of the value of cash dividends and ϕ is an estimate of the value of distributed franking credits. The true values of these parameters are 1 and 0, respectively. The final column reports the proportion of simulated estimates that lie more than 0.1 below and more than 0.1 above the true values.

Table 5
Proportion of Estimates Outside ± 0.1 of True Value for Different Econometric Methods and Screening Techniques.

		Simulated Sample Parameters				
Key Features		**Unscreened (A)**	**Screened (B)**	**Franked (C)**	**Big (D)**	**Small (E)**
% Franked divs.		80	80	100	80	80
% big firms		50	50	50	100	0
Max. drop-offs screen		none	±5	±5	±5	±5
Non-trading screen		none	±5	±5	±5	±5
Zero drop-offs		in	out	out	out	out
Average Number of Observations		1 000	748	759	856	641
Method 1	δ	[0.035, 1.847] 482, 333	[0.895, 1.352] 53, 582	[0.530, 1.595] 308, 456	[0.883, 1.312] 70, 478	[0.915, 1.422] 39, 683
	ϕ	[-1.706, 1.686] 445, 453	[-0.539, 0.348] 512, 247	[-0.983, 0.987] 420, 428	[-0.530, 0.301] 499, 225	[-0.621, 0.371] 548, 225
Method 2	δ	[0.819, 1.142] 181, 98	[0.922, 1.201] 32, 290	[0.642, 1.403] 277, 341	[0.938, 1.175] 21, 240	[0.886, 1.235] 60, 344
	ϕ	[-0.494, 0.246] 398, 210	[-0.390, 0.195] 445, 143	[-0.732, 0.654] 413, 376	[-0.339, 0.130] 482, 79	[-0.517, 0.256] 422, 183
Method 3	δ	[0.110, 1.878] 427, 392	[0.916, 1.358] 40, 614	[0.566, 1.577] 262, 495	[0.855, 1.308] 85, 460	[0.958, 1.450] 24, 771
	ϕ	[-1.631, 1.601] 444, 462	[-0.508, 0.336] 504, 237	[-0.915, 0.987] 439, 410	[-0.484, 0.371] 438, 287	[-0.616, 0.340] 586, 188
Method 4	δ	[0.891, 1.107] 67, 63	[0.949, 1.162] 9, 233	[0.784, 1.256] 189, 303	[0.941, 1.120] 12, 110	[0.965, 1.212] 5, 415
	ϕ	[-0.210, 0.212] 206, 228	[-0.242, 0.161] 306, 127	[-0.408, 0.461] 355, 360	[-0.192, 0.166] 237, 139	[-0.312, 0.172] 431, 114
Method 5	δ	[0.719, 1.214] 322, 187	[0.869, 1.300] 75, 462	[0.510, 1.556] 313, 422	[0.881, 1.222] 69, 342	[0.882, 1.312] 62, 523
	ϕ	[-0.500, 0.502] 373, 354	[-0.513, 0.340] 486, 217	[-0.941, 0.965] 425, 433	[-0.398, 0.255] 465, 182	[-0.499, 0.331] 482, 248
Method 6	δ	[0.819, 1.142] 181, 98	[0.922, 1.201] 32, 290	[0.642, 1.403] 277, 341	[0.938, 1.175] 21, 240	[0.886, 1.235] 60, 344
	ϕ	[-0.494, 0.246] 398, 210	[-0.390, 0.195] 445, 143	[-0.732, 0.654] 413, 376	[-0.339, 0.130] 482, 79	[-0.517, 0.256] 422, 183
Method 7	δ	[0.746, 1.244] 255, 262	[0.882, 1.300] 67, 497	[0.555, 1.562] 297, 438	[0.866, 1.200] 79, 277	[0.911, 1.338] 44, 574
	ϕ	[-0.494, 0.499] 362, 367	[-0.504, 0.351] 463, 223	[-0.948, 0.858] 417, 434	[-0.323, 0.299] 338, 254	[-0.517, 0.313] 501, 231
Method 8	δ	[0.891, 1.107] 67, 63	[0.949, 1.162] 9, 233	[0.784, 1.256] 189, 303	[0.941, 1.120] 12, 110	[0.961, 1.212] 5, 415
	ϕ	[-0.210, 0.212] 206, 228	[-0.242, 0.161] 306, 127	[-0.408, 0.461] 355, 360	[-0.192, 0.166] 237, 139	[-0.312, 0.172] 431, 114

Econometric methods 1-8 are defined in Table 2. The simulation procedure is described in Section 5.1 and sample screening procedures are described in Section 5.3. δ is an estimate of the value of cash dividends and ϕ is an estimate of the vale of distributed franking credits. The true values of these parameters is 1 and 0, respectively. The first number in each cell is the proportion of the 1,000 simulations for which the estimated value is more than 0.1 below the true value. The second number is the proportion for which the estimated value is more than 0.1 above the true value.

Table 6
The Value of dividends and franking credits implicit in dividend drop-offs.

Method	Parameter	Full Sample	Big Firms	Small Firms	Post 45-day rule	Post 45-day rule Big Firms	Post 45-day rule Small Firms
		Number of Observations					
		5640	2820	2820	3906	2040	1866
Method 1	δ	0.689 (0.091)	0.558 (0.139)	0.810 (0.118)	0.704 (0.116)	0.560 (0.170)	0.844 (0.157)
	ϕ	0.238 (0.189)	0.448 (0.291)	0.053 (0.245)	0.234 (0.244)	0.483 (0.361)	0.001 (0.329)
Method 2	δ	0.842 (0.030)	0.956 (0.039)	0.689 (0.047)	0.781 (0.038)	0.846 (0.048)	0.689 (0.062)
	ϕ	0.277 (0.061)	0.133 (0.078)	0.472 (0.095)	0.368 (0.079)	0.308 (0.099)	0.451 (0.128)
Method 3	δ	0.809 (0.096)	0.697 (0.147)	0.919 (0.126)	0.852 (0.121)	0.742 (0.175)	0.964 (0.167)
	ϕ	0.153 (0.201)	0.241 (0.308)	0.074 (0.261)	0.046 (0.255)	0.171 (0.370)	-0.071 (0.350)
Method 4	δ	0.832 (0.030)	0.921 (0.038)	0.713 (0.049)	0.767 (0.038)	0.820 (0.047)	0.692 (0.062)
	ϕ	0.359 (0.061)	0.243 (0.076)	0.514 (0.097)	0.446 (0.078)	0.415 (0.097)	0.489 (0.127)
Method 5	δ	0.727 (0.034)	0.907 (0.034)	0.641 (0.053)	0.719 (0.042)	0.930 (0.043)	0.620 (0.067)
	ϕ	0.385 (0.072)	0.247 (0.071)	0.439 (0.112)	0.312 (0.092)	0.148 (0.093)	0.367 (0.146)
Method 6	δ	0.842 (0.030)	0.956 (0.039)	0.689 (0.047)	0.781 (0.038)	0.846 (0.048)	0.694 (0.062)
	ϕ	0.277 (0.061)	0.133 (0.078)	0.472 (0.095)	0.368 (0.079)	0.308 (0.099)	0.451 (0.128)
Method 7	δ	0.750 (0.035)	0.902 (0.033)	0.678 (0.054)	0.727 (0.043)	0.908 (0.043)	0.643 (0.069)
	ϕ	0.431 (0.073)	0.299 (0.071)	0.485 (0.115)	0.362 (0.094)	0.236 (0.092)	0.402 (0.150)
Method 8	δ	0.832 (0.030)	0.921 (0.038)	0.713 (0.049)	0.767 (0.038)	0.820 (0.047)	0.692 (0.062)
	ϕ	0.359 (0.061)	0.243 (0.076)	0.514 (0.097)	0.446 (0.078)	0.415 (0.097)	0.489 (0.127)

Econometric methods are defined in Table 2. δ is an estimate of the value of cash dividends and ϕ is an estimate of the value of distributed franking credits. Data consist of all dividends paid on ordinary shares on the ASX from March 14, 1995 to November 29, 2002. Big firms are those with a market capitalization greater than $\$X$ million at the ex-date. Post 45-day rule refers to all observations after 1 July, 1997. Each cell contains a parameter estimate and its standard error (in parentheses).

Table 7
The Value of dividends and franking credits implicit in dividend drop-offs.

Method	Parameter	Full Sample	Big Firms	Small Firms	Post 45-day rule	Post 45-day rule Big Firms	Post 45-day rule Small Firms
		Number of observations					
		5640	2820	2820	3906	2040	1866
No Screening	δ	0.832	0.921	0.713	0.767	0.820	0.692
		(0.030)	(0.038)	(0.049)	(0.038)	(0.047)	(0.062)
	ϕ	0.359	0.243	0.514	0.446	0.415	0.489
		(0.061)	(0.076)	(0.097)	(0.078)	(0.097)	(0.127)
		Number of observations					
		4973	2760	2213	3473	1997	1476
Non-trading screen: 5 days	δ	0.831	0.918	0.707	0.765	0.818	0.685
		(0.030)	(0.037)	(0.050)	(0.038)	(0.047)	(0.064)
	ϕ	0.369	0.265	0.519	0.452	0.420	0.501
		(0.061)	(0.074)	(0.101)	(0.079)	(0.097)	(0.133)
		Number of observations					
		4873	2707	2166	3390	1953	1437
Max drop-off screen: 5 times	δ	0.829	0.918	0.701	0.760	0.814	0.681
		(0.029)	(0.035)	(0.049)	(0.036)	(0.044)	(0.061)
	ϕ	0.374	0.270	0.524	0.462	0.440	0.499
		(0.058)	(0.070)	(0.097)	(0.075)	(0.091)	(0.126)
		Number of observations					
		4132	2429	1703	2885	1757	1128
Zero drop-off screen	δ	0.877	0.933	0.793	0.798	0.832	0.747
		(0.030)	(0.035)	(0.053)	(0.037)	(0.045)	(0.066)
	ϕ	0.398	0.296	0.551	0.506	0.461	0.575
		(0.060)	(0.072)	(0.105)	(0.078)	(0.093)	(0.136)
		Number of observations					
		4057	2414	1643	2833	1743	1090
Small dividend screen: 1 cent	δ	0.879	0.934	0.794	0.802	0.833	0.752
		(0.030)	(0.035)	(0.053)	(0.038)	(0.045)	(0.066)
	ϕ	0.396	0.295	0.550	0.501	0.459	0.567
		(0.061)	(0.072)	(0.107)	(0.078)	(0.093)	(0.137)
		Number of observations					
		4045	2414	1631	2823	1743	1080
Low stock price screen: 20 cents	δ	0.875	0.934	0.781	0.795	0.833	0.731
		(0.030)	(0.035)	(0.055)	(0.038)	(0.045)	(0.069)
	ϕ	0.402	0.295	0.574	0.514	0.459	0.608
		(0.061)	(0.072)	(0.109)	(0.079)	(0.093)	(0.141)

Econometric methods are defined in Table 2. δ is an estimate of the value of cash dividends and ϕ is an estimate of the value of distributed franking credits. Data consist of all dividends paid on ordinary shares on the ASX from March 14, 1995 to November 29, 2002. Big firms are those with a market capitalization greater than $500 million at the ex-date. Post 45-day rule refers to all observations after 1 July, 1997. Each cell contains a parameter estimate and its standard error (in parentheses).

Table 8
The Value of dividends and franking credits implicit in dividend drop-offs.

Note	Parameter	Full Sample	Big Firms	Small Firms	Post 45-day rule	Post 45-day rule Big Firms	Post 45-day rule Small Firms
		Number of Observations[5]					
		5640	2820	2820	3906	2040	1866
1.	$\phi\left(\delta \equiv 1\right)$	0.046 (0.023)	0.095 (0.028)	-0.017 (0.036)	-0.002 (0.029)	0.067 (0.036)	-0.098 (0.048)
2.	F_1	0.00546	0.00157	0.01237	0.00981	0.00736	0.01343
	P – val	0.941	0.968	0.911	0.921	0.932	0.908
3.	F_2	0.00619	0.00559	0.01244	0.00981	0.00906	0.01565
	P – val	0.993	0.994	0.988	0.990	0.991	0.984
4.	Package Value Relative to Cash Dividend	0.997	1.034	0.946	0.961	0.999	0.972
	R^2 of Package vs. Cash Dividend	0.986	0.994	0.970	0.978	0.981	0.906

1. The value of cash dividends is constrained to be 100% of face value and ϕ is an estimate of the value of distributed franking credits conditioned on cash dividends being fully valued. Method 8 is used for the analysis. The table presents the estimate of ϕ with standard error in parentheses.
2. The F-statistic compares an unconstrained model in which δ and ϕ are estimated as free parameters against a constrained model in which δ is fixed to equal one and ϕ is estimated as a free parameter.
3. The F-statistic compares an unconstrained model in which δ and ϕ are estimated as free parameters against a constrained model in which δ is fixed to equal one and ϕ is fixed to equal zero.
4. The estimated value of the package of dividend plus franking credit is $\delta\, D_i + \phi\, D_i\, f_i\left(\frac{\tau_i}{1-\tau_i}\right)$, where δ and ϕ are estimated using Method 8. We regress the value of this package against the value of the cash dividend, D_i using OLS and report the slope coefficient and R^2.
5. Data consist of all dividends paid on ordinary shares on the ASX from March 14, 1995 to November 29, 2002. Big firms are those with a market capitalization greater than $500 million at the ex-date. Post 45-day rule refers to all observations after 1 July, 1997.

Table 9
Interpretation of Hathaway and Officer (2002) in Light of Multicollinearity Issues.

Panel A: Separate Values of Dividends and Franking Credits[3].

Sector	Small Companies		Large Companies		All Companies	
	Dividend	Franking Credit	Dividend	Franking Credit	Dividend	Franking Credit
Industrials	0.86	0.17	0.80	0.49	0.83	0.30
Resources	0.55	0.70	0.72	0.44	0.61	0.61
All	0.71	0.41	0.77	0.49	0.74	0.44

Panel B: Value of Package Relative to Cash Dividend[4].

Sector	Small Companies	Large Companies	All Companies
Industrials	0.97	1.11	1.02
Resources	1.00	1.00	1.00
All	0.97	1.08	1.02

[3] Hathaway and Officer (2002) model the ex-date price change as a function of dividends and franking credits $P_{i,t-1} - P_{i,t} = \delta\, D_i + \phi\, D_i f_i \left(\frac{\tau_i}{1-\tau_i} \right) + \varepsilon_i'$. They scale by dividends, $\frac{P_{i,t-1} - P_{i,t}}{D_i} = \delta + \phi\, f_i \left(\frac{\tau_i}{1-\tau_i} \right) + \varepsilon_i$,and use OLS to estimate $\frac{P_{i,t-1} - P_{i,t}}{D_i} = a + b\, f_i + \varepsilon_i$. Their *a* is an estimate of our δ , and $b \Big/ \left(\frac{\tau_i}{1-\tau_i} \right)$ is an estimate of ϕ . Since the corporate tax rate was 39% for their sample period, their estimate of *b* must be scaled up by 1.56 to yield an estimate of ϕ , and this is presented in Panel A.

[4] The value of the package of dividend and franking credit, relative to the dividend, is computed as $\delta + \phi\, f_i \left(\frac{\tau_i}{1-\tau_i} \right)$ where δ and ϕ are represented in Panel A, $\tau_i = 39\%$ and $f_i = 1$ for fully-franked dividends.

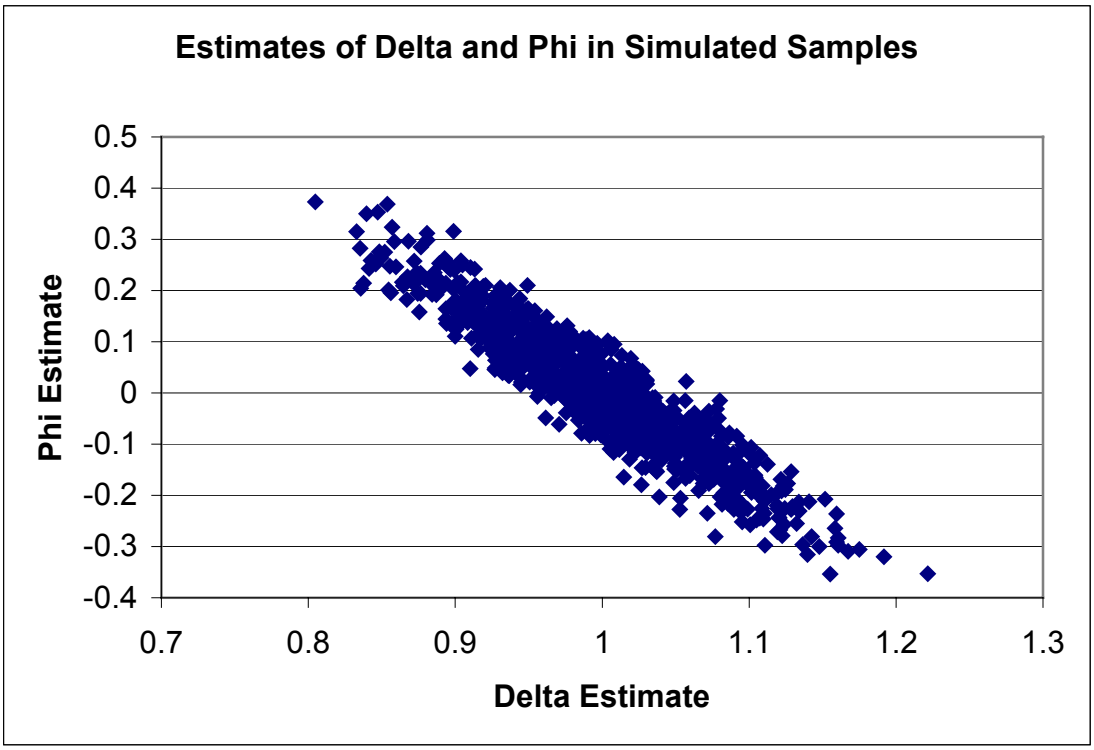

Figure 1: Estimates of delta and phi in simulated samples.

Attachment 2 – Report by Coraldeen on Replacement Cost of the Wilton-Wollongong Gas Pipeline

Please refer to next 10 pages.

Report for AGL Gas Networks Limited

Replacement cost of gas pipeline from Wilton to Wollongong

18 January 2005

Coraldeen Pty Limited
Canberra ACT

Summary

This report outlines the results of independent detailed estimations carried out for AGL Gas Networks Limited of the replacement cost of a hypothetical new gas pipeline from Wilton to Wollongong for pipe sizes of 200mm, 250mm, 300mm and 350mm nominal diameter.

The results are shown in the following table.

Estimated pipeline cost	pipe size			
	200mm	250mm	300mm	350mm
$million 2004	14.3	16.8	19.6	21.3

Replacement cost of gas pipeline from Wilton to Wollongong

Background

AGLGN submitted an Access Arrangement (AA) to the NSW regulator The Independent Pricing and Regulatory Tribunal (IPART) covering its NSW gas pipeline networks.

As part of its assessment of the AA, IPART is considering a review of the optimised design and costs of the gas pipeline that supplies gas into the Wollongong area from an off-take at the Wilton Trunk Receiving Station on the Moomba to Sydney pipeline.

IPART's consultant, McLennan Magasanik Associates Pty Ltd (MMA), employed a simple "rule of thumb" for estimating the replacement cost of the optimised pipeline based on applying a unit rate of $1,200/km.mm for the trunk main and $1,480/km.mm for the primary main[1].

AGLGN has a concern that such an estimate is not truly cost reflective of the topography of the route, additional engineering requirements to mitigate the risk imposed on the pipeline due to ongoing mining activities and residential developments in the Wollongong area.

This report has been prepared in response to a request by AGL Gas Networks Limited (AGLGN) to address these issues and to develop an independent estimate of the replacement cost for pipeline assuming:

- A pipeline of uniform diameter from Wilton to Wollongong
- 6,895kPag maximum allowable operating pressure (MAOP)
- options of pipe sizes of 200mm, 250mm, 300mm and 350mm nominal bore
- current engineering practice
- a stand alone project.

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Introduction

The budget replacement cost is required to be determined of a hypothetical new gas pipeline from Wilton to Wollongong for pipe sizes of 200mm, 250mm, 300mm and 350mm nominal diameter.

In each case, the pipeline follows the route of AGLGN's existing trunk pipeline from the AGLGN meter station at Wilton to a regulating/meter station at Mt Keira 21.6km downstream and from there the route of the existing primary main to the outskirts of Wollongong, over a distance of 11.2km. The total length of pipeline from Wilton to Wollongong is 32.8km.

All relevant components of pipeline development cost including direct costs, easement or ROW acquisition, EPCM, project overheads, and interest costs of project funding are to be included.

Mainline valves and scraper stations have been allowed for at both ends of the pipeline and adjacent to the existing Mt Keira station. As an additional precaution, a mainline valve has also been specified just prior to the point of entry of the pipeline through the Cordeaux Colliery site.

[1] In 1996 dollars.

At the request of AGLGN no allowance has been made for metering or pressure regulating facilities at either end of the pipeline.

Pipeline route

Fig1. Approximate route of pipeline from Wilton to Wollongong

Varying terrain and conditions encountered along the pipeline route as well as residential and industrial developments, road, creek, watercourse and the need for directionally drilled crossings have been considered in detail. An on-ground inspection of the route and examination of alignment sheets and aerial photographs of the existing pipelines facilitated this process.

The pipeline traverses relatively difficult topography and conditions. Near Wilton, rural sub-divisions and road developments impact on the pipeline (Fig 2).

A substantial portion of the route is also subject to occasional subsidence caused by long wall coal mining activity underground. This mining is still taking place.

The route passes through the Cordeaux Colliery site and from there to the top of the escarpment above Wollongong passes almost continuously through a water catchment area[2] in terrain with many gullies and watercourses and many areas of rock (Fig 3). Pipeline construction activities through the water catchment areas are subject to significant environmental constraints imposed by the catchment authorities.

The existing pipeline passes through a tunnel down the escarpment. A new pipeline would make use of directional drilling vertically down and inside the escarpment face.[3] This has been assumed for this estimate.

From the bottom of the escarpment the route passes to the north of Mount Kembla through remaining open land. A new residential subdivision in this area abuts the southern edge of the easement over the last approximately 600 metres (Fig 4).

Fig2. Picton-Wilton road crossing near Wilton (KP4.4)

[2] Over 20km of the pipeline passes through catchment area.
[3] The Eastern Gas Pipeline from Sale to Sydney made use of this technique to solve this problem in 2001.

Fig3. In water catchment area near KP18

Fig4. Near Cordeaux Heights (KP32) –residential subdivision is to the right.

Design considerations

The Australian pipeline code AS2885 requires pipeline class locations along an existing pipeline route to be regularly reviewed and this estimate has adopted current class locations for the pipeline. These are predominantly R2 (semi-rural). Two small sections where the pipeline passes through the Cordeaux Colliery site (from KP12.35 to KP13.1) and where the route is adjacent to a current residential subdivision near the end point at Wollongong are rated T1 (low density development).

For design purposes, a maximum allowable operating pressure (MAOP) of 6,895 kPag has been assumed to apply to the whole pipeline[4]. Given the class locations and known problems with mining subsidence along most of the route prudent pipeline practice calls for use of thicker pipe wall sections than might otherwise be employed. For this estimate a maximum pipe stress factor of 60% has been assumed[5], utilising relatively conservative X-52 pipe. Lower stress factors of 50% apply from the start of the water catchment area and main mine subsidence region. 40% has been specified for the T1 areas.

These combinations ensure a thicker pipe wall is provided in locations where this is desirable and the pipe has a better capacity to withstand stresses imposed by subsidence effects or arising from a greater chance of third party interference on the pipeline in more populated areas.

In keeping with recent pipeline practice fusion bonded epoxy coating is specified, and given a preponderance of rocky soil (solid rock in some areas) the pipe is externally protected with a rock jacket or equivalent coating where appropriate. For the two larger diameter pipes considered here, concrete weight coating is applied at creek crossings and swampy areas. Internal lining of the pipe is also specified in line with more recent experience of problems with cleaning pipe during commissioning.

Cost parameters

While there are many variables that affect a pipeline cost, the main parameters are the unit cost of construction, the price of pipe and to a lesser extent coating. In this instance acquisition of an easement would also be a significant challenge, given the proximity to major urban areas, with resultant high land values and increased expectation of high easement compensation costs.

Importantly, in this case, the pipeline traverses a large water catchment area with attendant high environmental standards required by the relevant authorities in construction of a pipeline. Of lesser impact, but no less challenging, is the proximity of power line easements which run in parallel in several areas. These affect construction because of safety concerns and require additional design measures to mitigate against potentially lethal induced voltages.

The approach to the cost estimation of this pipeline has been to break down the pipeline into more than 120 sections so that for each resulting section variations in terrain, road, creek and other special crossings and conditions affecting pipeline construction can be taken into account in great detail.

[4] To provide additional safety in the Wollongong area, a new pipeline might also be operated at a lower MAOP downstream of the site of the existing pressure reduction station (KP21.6)
[5] AS2885 allows up to 72%.

These details and individual costs derived for the various pipeline construction and project activity costs are shown in the detailed cost estimate tables.

The following are significant parameters affecting the final cost estimate:

- Price of X-52 linepipe

A $/tonne unit cost has been derived for current purposes from a recent budget quotation by a local pipe supplier for 35km of 250mm pipe coated with polyethylene.[6] The estimated cost of coating this pipe with polyethylene has been deducted to derive a bare steel price in $/tonne.

A $/tonne unit price can be applied across the range of pipe sizes contemplated here to determine the supply price of line pipe.

- Easement, land, ROW costs

Valuations for land where obtained from the NSW Lands Department web site where data is listed for rural homesites in Bargo (applicable for use near Wilton) and Thirroul (applicable for use in the proximity of Wollongong). A cost per hectare was assumed for the water catchment and industrial owned land areas[7].

After assuming a "degree of affectation" of 20%, a 20 metre easement and allowing a markup of 7% for survey and land agent costs a total cost for the easement acquisition of $2.6 million was derived[8].

- Pipeline construction cost

The estimate for pipeline construction[9] starts with a unit cost (in $/km.mm) for a pipeline constructed under the most favourable conditions- the base construction cost. The actual cost of construction for a particular section of the pipeline under consideration will depend on further input data on the terrain and ground conditions. The base unit cost employed here ($285/km.mm) is representative of current conditions.

- Coating

Appropriate unit costs have been employed in determining the costs of internal lining and external coating of the pipe. Where pipeline conditions call for it, additional external protection has been included by way of a "Rock Jacket" or equivalent coating and, for the two larger diameter pipes, concrete weight coating in creek crossings and swamps.

It will be seen that a significant length of the pipeline has been assumed to require such extra coating, reflecting the benefit of such protection in areas with relatively higher rock content[10].

[6] The quotation was $59.10/metre for 35,000 metres of 5.4mm wall thickness pipe and is current.
[7] $20,000/ha.
[8] In the detailed costing equivalent per hectare costs reflect significantly higher costs for easements in more populated areas by comparison with the catchment area.
[9] The detailed costing tables attached show what is meant here by "pipeline construction"- a significant number of other activities are costed separately to derive a total direct cost of construction..
[10] The conditions along a large part of the route are not conducive to the alternative use of top and bottom padding material to avoid damage to the coating of the pipe in the trench.

- Crossings

Separate costings have been undertaken for the various crossings encountered along the routes such as road crossings (either open cut or bored); watercourse and creek crossings and directional drills. The appropriate pipeline length involved in each crossing has been derived by examination of the alignment sheets and these details are used to derived an individual cost for each crossing.

The resulting cost estimates are summarised in the following table. More detailed breakdowns of the estimates together with further descriptions of the input data and explanatory notes to the calculations are provided in the appendices to this report.

Budget replacement cost estimate of Wilton to Wollongong pipeline

Item	Pipe diameter 200 mm	250mm	300mm	350mm
Pipeline construction costs		$,000 (2004)		
Line pipe (X-52)	1,113	1,560	2,191	2,636
Delivery after coating to site	15	20	26	30
Coating (fbe,RJ, weight where applic.)	1,006	1,254	1,501	1,647
Internal lining	249	310	368	404
Pipeline construction	5,809	6,821	7,760	8,340
Joint coating	41	51	62	68
Cathodic protection	31	31	31	31
Induction bends, markers, signs	69	84	100	110
Valve station installations	404	523	648	731
Scraper station installations	594	767	953	1,076
SCADA, comms, electr, instrumentation	98	98	98	98
Construction contingency (5%)	471	576	687	759
sub total	9,900	12,096	14,424	15,929
Easement and indirect costs				
Easement/ROW/land and compensation	2,597	2,597	2,597	2,597
Spares	99	121	144	159
Cost of initial linepack	4	6	9	10
EPCM	693	847	1,010	1,115
Overheads, including insurance	594	726	865	956
Interest during construction	382	451	524	571
sub total	4,369	4,747	5,149	5,409
Total capital cost	14,269	16,843	19,573	21,338

The estimates are considered to reflect the level of accuracy possible at the budget preparation stage of a project, which is at best +/- 10%.

A contingency of 5% on construction direct costs has been included to allow for unforseen items.

Discussion

MMA[11] has previously derived ORC estimates for a range of pipeline size combinations based on applying a unit rate of $1,200/km.mm for the trunk main and $1,480/km.mm for the primary main[12].

For comparison purposes, the estimates of capital cost tabulated above can also be expressed in $/km.mm terms:

- $2,175/km.mm for 200mm pipe
- $2,054/km.mm for 250mm pipe
- $1,989/km.mm for 300mm pipe
- $1,859/km.mm for 350mm pipe

The MMA figures are in 1996 dollars. Equivalent rates shown above are in 2004 dollars.

Notwithstanding the time interval of eight years there remains a considerable discrepancy between the estimates. This may be due to the fact that this current estimate makes a more detailed appraisal of the challenging pipeline topography and conditions that would be encountered by a pipeline constructor on this pipeline. A "rule of thumb" approach cannot take all these factors into account.

Conclusion

The estimates presented in this report represent the total cost of replacement of the existing pipeline and take into account topography; risk of subsidence; modern pipeline construction practice; current costs of pipe, construction and easement acquisition; and existing residential and industrial developments along the pipeline.

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Consultant

Coraldeen Pty Ltd
Canberra
18 January 2005.

[11] McLennan Magasanik Associates Pty Ltd : Assessment of the Wollongong Trunk Pipeline Depreciated Optimised Replacement Value; dated 11 November 2004.

[12] These values are believed to be based on 1996 replacement cost figures assumed by AGLGN.

Attachment 3 – Ancillary Charges

Ancillary charges now proposed by AGLGN to be effective as from July 1, 2005 are set out below:

- Request for Service - $60 per hour plus $60 per hour after the first hour

This charge is based on the hourly cost for provision of this service

- Special Meter Read – $25

This charge is based on the estimated contractor, administration and infrastructure cost of providing this service, given forecast volume of work and contractor rates

- Residential Disconnection Fee - $100

This charge covers disconnection of meters with a capacity of less than or equal to $6m^3/hr$. The specific method of disconnection will be at the discretion of AGLGN to ensure the site is able to be left in a safe state. The fee also covers the cost of subsequent reconnection.

The reason for having the reconnection fee built into the disconnection fee, and not separate is that if one retailer disconnects and fails to arrange a reconnect before a customer transfer, the new retailer should not have to fund a reconnect when they were not responsible for the disconnect. This will remove a potential barrier to competition.

- Business Disconnection Fee - $300

This charge covers disconnection of meters with a capacity of greater than $6m^3/hr$. The specific method of disconnection will be at the discretion of AGLGN to ensure the site is able to be left in a safe state. The fee also covers the cost subsequent reconnection.

The reason for having the reconnection fee built into the disconnection fee, and not separate is that if one retailer disconnects and fails to arrange a reconnect before a customer transfer, the new retailer should not have to fund a reconnect when they were not responsible for the disconnect. This will remove a potential barrier to competition.

With effect from 1 July 2007 and each year thereafter, the escalation formula set out in Section 3.10 of the Access Arrangement will apply to charges for Ancillary Services.

Attachment 4 – Revised Market Expansion Capital Expenditure

As set out in Section 4.1 of this Response, the analysis supporting the Draft Decision is flawed in that the forecast cost of service and forecast sales volumes are based on two separate and inconsistent demand forecasts and needs to be corrected.

This attachment recalculates the market expansion capital expenditure forecast based on:

- The demand forecast incorporated in the Draft Decision adjusted only for the effects of the Sydney Water Plan as set out in Section 3.1 of this Response; and
- The unit rates in the Draft Decision adjusted only to correct the error in the calculation of the supervision costs of minor capital works set out in Section 4.4 of this Response.

The following table shows the updated capital expenditure as proposed by AGLGN, taking into consideration the additional net growth and changes in unit rates as discussed above.

Table A2/1 – Revised Market Expansion Capex Forecast

Market Expansion Capital ($m) real 04/05	2004	2005	2006	2007	2008	2009	2010
Mains	10.1	10.4	12.9	12.2	10.8	10.8	10.8
Services	23.8	24.4	25.5	25.2	25.4	25.5	25.6
Meters	17.5	15.4	16.5	16.6	16.8	17.0	17.3
Total	**51.3**	**50.3**	**55.0**	**54.0**	**53.0**	**53.3**	**53.7**

Tables 2 to 7 shows the net movement in customer connections for which capital expenditure has now been included in the above table, as well as the revised capital expenditure based on the additional customers.

Table A2/2 - Additional/(Reduced) Customer Additions

Additional/(Reduced) customers	2004	2005	2006	2007	2008	2009	2010
New homes - built up	113	270	482	587	700	820	946
New homes - new estate	388	811	1272	1370	1453	1522	1576
Medium density	3710	1616	2913	3209	3513	3823	4142
Business	(17)	(31)	(44)	(55)	(64)	(72)	(79)

Table A2/3 - Additional/(Reduced) Mains Costs

Additional/(Reduced) Mains Costs ($'m) real 04/05	2004	2005	2006	2007	2008	2009	2010
New homes- built up	0.08	0.19	0.34	0.42	0.50	0.58	0.57
New homes – new estate	0.20	0.41	0.65	0.70	0.75	0.78	0.81
Medium Density	0.15	0.07	0.12	0.13	0.15	0.16	0.17
Business	(0.04)	(0.08)	(0.11)	(0.14)	(0.16)	(0.18)	(0.20)

Table A2/4 - Additional/(Reduced) Services Costs

Additional/(Reduced) Services Costs ($m) real 04/05	2004	2005	2006	2007	2008	2009	2010
New Homes- built up	0.15	0.35	0.63	0.77	0.91	1.07	1.23
New homes – new estate	0.28	0.59	0.93	1.00	1.06	1.11	1.15
Medium Density	0.36	0.16	0.28	0.31	0.34	0.37	0.40
Business	(0.02)	(0.04)	(0.06)	(0.07)	(0.08)	(0.09)	(0.10)

Table A2/5 - Additional/(Reduced) Meter Costs

Additional/(Reduced) Meter Costs ($m) real 04/05	2004	2005	2006	2007	2008	2009	2010
New Homes- built up	0.02	0.05	0.09	0.10	0.13	0.15	0.17
New homes – new estate	0.08	0.15	0.23	0.25	0.26	0.27	0.28
Medium Density	2.59	1.00	1.80	1.98	2.17	2.36	2.56
Business	(0.05)	(0.09)	(0.12)	(0.15)	(0.18)	(0.20)	(0.22)

Table A2/6 - Additional/(Reduced) Total Costs

Additional/(Reduced) Total Costs ($m) real 04/05	2004	2005	2006	2007	2008	2009	2010
New Homes- built up	0.25	0.59	1.06	1.29	1.54	1.80	2.08
New homes – new estate	0.56	1.16	1.81	1.95	2.07	2.17	2.25
Medium Density	3.11	1.22	2.20	2.43	2.66	2.89	3.13
Business	(0.16)	(0.21)	(0.37)	(0.37)	(0.43)	(0.48)	(0.53)

Table A2/7 - Additional Capex due to additional net growth

Additional Capex due to additional net growth ($m) real 04/05	2004	2005	2006	2007	2008	2009	2010
Mains	0.39	0.60	1.01	1.12	1.23	1.34	1.46
Services	0.77	1.06	1.78	2.01	2.23	2.46	2.68
Meters	2.64	1.10	1.99	2.18	2.38	2.58	2.79
Total	**3.80**	**2.76**	**4.78**	**5.31**	**5.84**	**6.38**	**6.93**

Attachment 5 – Calculation of the IT Utilisation Fee

The IT Utilisation Fee represents a charge by AGL Corporate Services Ltd to AGLGN to recover the "return on" and "return of" capital expenditure incurred by AGL Corporate Services for and on behalf of AGLGN.

This charge has been calculated to have the same effect on the Regulatory Cost of Service as if the expenditure had been included in the Regulatory Asset Base.

The calculation is set out in Table A5. This calculation is an exact replication of the method used by IPART in its financial model to roll forward the Regulatory Asset Base and to calculate the Regulatory Cost of Service.

AGLGN has depreciated the IT capital expenditure using straight-line depreciation and a five-year asset life.

In its Draft Decision IPART requires:

> *"AGLGN to amend its proposed access arrangement to deduct its depreciation forecast at the last review (adjusted for actual inflation over the period) when rolling forward the capital base to the start of the proposed access arrangement period"*[1]

The full "depreciation forecast at the last review" has been utilised in the roll forward of the regulatory asset base on those assets recorded directly in the Regulatory Asset Base of AGLGN. Therefore depreciation of the additional IT assets has been modelled to commence as from 1 July 2005. This is after the completion of the period considered in the last review, but twelve months prior to the commencement of the proposed access arrangement period.

[1] IPART Draft Decision section 7.5.3

Table A5 - AGLGN – Calculation of IT Utilisation Fee – 2005/06 to 2009/10

	99/2000	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	Total
CPI	1.0238	1.0597	1.0286	1.0309	1.0235	1.0250	1.0250	1.0250	1.0250	1.0250	1.0250
Cumulative CPI	1.0238	1.0849	1.1159	1.1504	1.1775	1.2069	1.2371	1.2680	1.2997	1.3322	
Cumulative CPI to convert to $2005							1.0250	1.0506	1.0769	1.1038	
Roll Forward of Asset Base											
Opening Balance		6.800	12.006	16.349	22.455	26.682	21.879	16.820	11.494	5.890	
Capital Expenditure	6.800	4.800	4.000	5.600	3.700						24.900
Escalation		0.406	0.343	0.505	0.528	0.667	0.547	0.420	0.287	0.147	3.851
Depreciation						- 5.470	- 5.607	- 5.747	- 5.890	- 6.038	
Closing Balance	6.800	12.006	16.349	22.455	26.682	21.879	16.820	11.494	5.890	-	
Return of Capital											
Asset Value						27.349	22.426	17.240	11.781	6.038	
Depreciation Rate						20%	25%	33%	50%	100%	
Return of Capital						5.470	5.607	5.747	5.890	6.038	28.751
Return on Capital											
Asset Value											
Rate of Return - Real	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	
Rate of Return – Nominal						**9.67%**	**9.67%**	**9.67%**	**9.67%**	**9.67%**	
Return on Capital						1.532	1.177	0.805	0.412	-	3.926
Total IT Utilisation						7.001	6.784	6.551	6.303	6.038	32.677
Less Prior Regulatory Period						- 7.001					- 7.001
IT utilisation Cost 2006-2010						-	6.784	6.551	6.303	6.038	25.676
Conversion To Mid-Year Cash							- 0.306	- 0.296	- 0.284	- 0.272	-

	99/2000	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	Total
Flow											1.159
IT Utilisation Fee (Nominal $)							**6.478**	**6.256**	**6.018**	**5.765**	**24.517**
IT Utilisation Fee (Real $2005)							**6.320**	**5.954**	**5.589**	**5.223**	**23.086**