2 September 2003

Queensland Competition Authority
GPO Box 2257
Brisbane QLD 4001

Re: Dalrymple Bay Coal Terminal Draft Access Undertaking

The Queensland Competition Authority ('QCA') has issued a *Request for Comments on the Dalrymple Bay Coal Terminal Draft Access Undertaking* ('Draft Undertaking') Part 5 of the *Queensland Competition Authority Act 1997*. The QCA have advised that to promote consistency across the industries they regulate they were keen to resolve common issues related to the rate of return (cost of capital). Further, the Draft Undertaking would be the first of a new round of industry regulatory arrangements where the original approach to the cost of capital would be reviewed. As Envestra's Brisbane gas distribution network is regulated by the QCA it has become necessary for Envestra to participate in the consultation process for the Dalrymple Bay Coal Terminal. Envestra's submission focuses on the rate of return issues raised in chapter 5.4 of the Draft Undertaking.

The cost of capital is one of the most important factors in any third party access decision due to the capital-intensive nature of the businesses being regulated. The regulatory cost of capital must recognise the link between risk and reward and provide a return commensurate with the variability inherent in the cash flows the business is expected to generate.

Regulators have the opportunity to facilitate industry growth by creating an environment conducive to investment or stifle it by setting low rates of return and/or becoming overly intrusive. The latter has tended to prevail. The Productivity Commission in the *Review of the National Access Regime* added impetus to the emerging recognition that the regulatory regime must become more sympathetic to the needs of investors:

> *"But most importantly, the national access regime does not do enough to guard against the possibility that investment in essential infrastructure will be deterred. So-called 'regulatory risk' under the regime is greater than it need be. There is a danger that the regime could be applied to projects that should not be regulated at all. As outlined above, there is a significant risk that arbitrated determinations under the regime could go beyond appropriating genuine monopoly rent. Furthermore, the fact that coverage and other determinations are generally made*

after a facility is in place gives rise to the possibility of regulatory 'moral hazard'…Thus significant modifications to the regime are required".[1]

"……….., support for specific measures to facilitate new investment within access regimes generally, and Part IIIA in particular, has grown during this inquiry. In the [Productivity] Commission's view, the case for such measures is compelling. Thus, ***the focus for policy makers should not be on whether, but how to facilitate investment****."*[2] (our emphasis)

"In relation to the level of prices, attempts to be too precise in removing the potential for service providers to earn monopoly rents carries significant risk for investment."[3]

In evaluating Australia's regulatory regime it is clear that the Productivity Commission found that there are tangible benefits to be gained from a light-handed, investor friendly regulatory approach.

Envestra believes that one means of establishing a light-handed regulatory approach would be to base regulatory determinations on a pre-tax rate of return. The pre-tax approach has the advantages of being simple to apply, less data intensive than the post-tax method and it will not distort Fiscal Policy. Furthermore, following an extensive consultation on the weighted average cost of capital IPART has reaffirmed its supported for the pre-tax approach:

"The Tribunal has considered stakeholder submissions in response to the discussion paper and is inclined toward adopting a WACC that is:

- *presented in real, pre-tax terms*
- *utilises a statutory tax rate rather than an effective tax rate.*

The Tribunal is also inclined to adopt a forward transformation, consistent with market practice, in the calculation of the WACC."[4]

Our comments on the Draft Undertaking are provided in Appendix A. In making this submission Envestra notes that it has not been able to make detailed comments on some matters raised in the Draft Undertaking because we have insufficient detailed knowledge of the coal industry. Should you wish to discuss any aspect of this submission please call me on (08) 8227 1500.

Yours sincerely

Andrew Staniford
Commercial Manager

[1] Productivity Commission *Review of the National Access Regime – Inquiry Report*, September 2001, pp xxi
[2] ibid, pp xxv
[3] Productivity Commission *Review of the National Access Regime – Inquiry Report*, September 2001, pp.339
[4] IPART, Regulatory arrangements for the NSW Distribution Network Service Providers from 1 July 2004, Issues Paper DP58, November 2002, pp19.

APPENDIX A

1 RATE OF RETURN

The critical parameter in any investment decision is the expected rate of return. If the expected rate of return is below the investors internal hurdle rate then investment does not proceed. Furthermore, risk and return must be balanced and the riskier the investment the higher the required rate of return.

The generally accepted practice is to calculate the weighted average cost of capital ('WACC') using the standard Capital Asset Pricing Model ('CAPM') to derive the cost of equity and assumptions about the cost of debt and gearing levels. As many of the inputs into the WACC are unobservable the outcomes are necessarily subjective. This view is supported by the Monopolies and Mergers Commission (UK):

> "*…we do not believe the CAPM approach can be applied with precision, or in isolation*."[5]

To accommodate this imprecision Service Providers calculate the WACC then add a margin to allow for unforeseen circumstances[6] that may affect returns from the project. The WACC then becomes the hurdle rate against which the decision to invest, or not invest, is made. Regulators have taken a different approach by focusing on the theory behind the CAPM and removing all allowances for business specific and regulatory risk, justified by the theory of diversification[7]. The result is that regulatory WACC's have been lower than investors internal hurdle rate, meaning that only very low risk investment goes ahead constraining the provision of infrastructure.

Envestra advocates a light-handed approach to regulation that provides an environment conducive to investment.

2 Pre-Tax or Post-Tax WACC

Consistent with a light-handed regulatory regime Envestra, and other regulators[8], prefer the use of the pre-tax WACC. The pre-tax approach is much simpler to administer, less intrusive and is Fiscal Policy neutral. Conversely, the post-tax approach requires detailed information about tax asset values, tax depreciation rates and asset categories to calculate the amount of regulatory tax to be allowed in Total Revenue. The pre-tax WACC avoids all of this complexity via the inclusion of the statutory tax rate in the WACC formula.

Moreover, the post-tax approach unreasonably distorts Fiscal Policy. The Commonwealth government formulates income tax and depreciation arrangements to achieve its macroeconomic policy objectives. Under the post-tax approach Regulators have been passing all of the tax related

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[5] Monopolies and Mergers Commission, *BG plc, A report under the Gas Act 1986 on the restriction of prices for gas transportation and storage services*, May 1997, pp34

[6] This is analogous to the asymmetric allowance incorporated into the WACC by DBCT.

[7] Office of the Regulator-General, *2003 Review of Gas Access Arrangements – Position Paper*, September 2001 pp41-43

[8] SAIPAR, OffGAR, IPARC and IPART

investment incentives implemented by the Commonwealth government through to consumers in the form of lower prices. For example, the ACCC[9] and the Victorian Essential Services Commission[10] ('ESC') do not allow the benefits of accelerated depreciation related to the 20 year effective life caps to be retained by the Service Providers. This unequivocally contravenes the intent of that Fiscal Policy initiative as announced by the Honourable Ian Macfarlane MP Minister for Industry, Tourism and Resources:

> *"“The government will introduce effective life caps for these large assets. This has* ***positive taxation and cash flow implications for companies investing*** *[emphasis added] in the capital-intensive areas of resource and energy development……. These lower caps will lure further overseas investment in the country's capital intensive resource industry and expand our future gas infrastructure."*[11]

The ACCC and ESC approach did not have positive cash flow implications for the Service Providers. The ACCC and ESC distorted the intended effect of Fiscal Policy by not allowing the Service Providers to retain the benefits of accelerated depreciation allowances. Regulators do not set macroeconomic policy. The Regime should not be able to distort macroeconomic policy objectives. The use of a pre-tax WACC would avoid these type of policy conflicts.

The reasons detailed above are not exhaustive but demonstrate the inherent disadvantages of the post-tax approach over the real pre-tax approach. A pre-tax approach will simplify the regulatory process whilst achieving the same objectives in a light-handed manner. Therefore, the pre-tax approach is appropriate for regulatory purposes.

3 Real Pre-Tax WACC Formulation

A WACC quoted in real terms multiplied by the current cost asset base[12] provides the return on assets component of revenue. The real pre-tax WACC is derived from the nominal post-tax WACC formula below:

$$WACC_{nominal\ post-tax} = R_e \bullet \frac{E}{V} \bullet \frac{1-t_c}{(1-t_c(1-\gamma))} + R_d \bullet \frac{D}{V} \bullet (1-t_c)$$

Where:
E = market value of equity
D = market value of debt
V = (D + E)
R_e = return on equity
R_d = return on debt

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9 ACCC, Final Decision - GasNet Australia access arrangement revisions for the Principal Transmission System, 13 November 2002, pp78-80

10 ESC, *Review of Gas Access Arrangement Review – Final Decision*, October 2002, pp379-386

11 www.minister.industry.gov.au/media_releases.cfm?objectid=5C721EBE-6BBE-4AD7-9844382999B2E065

12 That is, the price, subject to the 'X' factor, is allowed to increase in accordance with inflation within a regulatory period. At reset the adjustment can be achieved by adjusting the asset value. It is usual for the capital asset base to be valued on current cost accounting principals.

π = inflation rate
t_c= corporate tax rate
γ= value of imputation credits

The nominal post-tax WACC is then converted to a real pre tax WACC using either (or both) of the two conversion methodologies detailed below[13]. The 'correct' answer lies between the two outcomes so an average is used as a point estimate for the real pre-tax WACC.

Conversion Methodology 1:

Step 1: convert the nominal post-tax rate of return (WACC $_{\text{nominal post-tax}}$) into a nominal pre-tax rate by dividing by the tax rate (t_c) to get:

$$WACC_{nominal\ pre-tax} = \frac{WACC_{nominal\ post-tax}}{(1-t_c)}$$

Step 2: convert the nominal pre-tax rate of return (WACC $_{\text{nominal pre-tax}}$) into a real pre-tax rate (WACC $_{\text{real pre-tax}}$) by using the Fisher equation to get:

$$WACC_{real\ pre-tax} = \left(\frac{1+WACC_{nominal\ pre-tax}}{(1+\pi)}\right) - 1$$

Conversion Methodology 2:

Step 1: convert nominal post-tax rate of return (WACC $_{\text{nominal post-tax}}$) into a real post tax rate (WACC $_{\text{real post-tax}}$) by using the Fisher equation to get:

$$WACC_{real\ post-tax} = \left(\frac{1+WACC_{nominal\ post-tax}}{(1+\pi)}\right) - 1$$

Step 2: convert real post tax rate (WACC $_{\text{real post-tax}}$) into a real pre tax rate (WACC $_{\text{real pre-tax}}$) by dividing by the tax rate (t_c) to get

$$WACC_{real\ pre-tax} = \left(\frac{WACC_{real\ post-tax}}{(1-t_c)}\right) - 1$$

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[13] Davis K., *The Weighted Average Cost of Capital for Access Arrangements for Envestra. A Report prepared for the South Australian Independent Pricing and Access Regulator (SAIPAR)*, October 20, 1999, pp10-11

3.1 Return on Equity (R_e)

A key component of the WACC formula is the return on equity[14], which is calculated using the Capital Asset Pricing Model ('CAPM') from the following formula:

$$R_e = R_f + \beta_e(R_m - R_f)$$

Where,
R_f = represents the nominal return on a risk free asset
$\beta_{e =}$ represents the equity beta
$R_m - R_f$: = represents the market risk premium

The version of the CAPM, as described above, is the generally accepted method for estimating the required return on equity for use in the WACC. The CAPM provides a forward-looking measure of the risk adjusted return on equity required to attract and maintain equity in a business. It requires the estimation of the risk free rate, the expected return on the market portfolio and a measure of beta (β_e).

3.2 Risk Free Rate (R_f)

The yield on the ten year Commonwealth Government bond rate generally accepted as the appropriate benchmark for the risk free rate. To adjust for any unusual events that may affect the bond market the average yield on the ten year Commonwealth Government bond over a period of either 20 and 40 days is recommended.

3.3 Market Risk Premium ($R_m - R_f$)

The equity or market risk premium is a measure of the premium associated with holding a market portfolio of investments. The premium measures the difference between the expected return from holding such investments (R_m) and the risk free rate (R_f).

The long-term historical average provides the best point estimate of the market risk premium as past outcomes heavily influence investors' expectations. Short-term market perturbations do receive a lot of media coverage have purported to show that the market risk premium is declining. However, the market risk premium is mean reverting, which makes the long-term average is the relevant measure for the CAPM. Practitioners in the financial markets also support this approach:

> "*We do not believe that there is sufficient empirical evidence to support the alleged decline over recent years in the Australian market. ….. It is proposed that a market risk premium of 7% is more appropriate based on published research and given the absence of firm evidence regarding a downward trend in market risk premia in Australia*".[15]

The average annual Australian MRP from 1883 to 2000, as measured by the average annual excess returns from holding shares, using the All Ordinaries Index, compared to 10 year

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[14] The terms cost of equity and cost on equity are used interchangeably

[15] Queensland Treasury Corporation, *Draft Decision on the Queensland Transmission Network Revenue Cap Response*, August 2001, pp 19.

Commonwealth bond yields, was 7.3 percent per annum[16]. A comparable MRP of 7.1 percent from 1900 to 2000 was found by Dimson, Marsh and Staunton (2000)[17]. The DCBT Management estimate of the market risk premium of 7.0 percent appears reasonable, albeit conservative compared to the empirical analysis.

3.4 Return on Debt (R_d)

The debt margin is added to the risk free rate to provide an estimate of the cost of debt for the business. The business' creditworthiness affects its borrowing costs and debt margin. The debt margins allowed in Envestra's two most recent regulatory determinations are detailed below.

Network	Credit Rating	Debt Margin
Victoria[18]	BBB+	1.70%
Queensland[19]	BBB+	1.55%

If DBCT's credit rating is lower than BBB+ we would expect the debt margin to be higher than 1.55% – 1.70% range used in other regulatory decisions.

3.5 Equity Beta (β_e)

Envestra has been unable to locate any independent empirical analysis on the value of equity beta for coal export terminals. However, intuitively we would expect the sensitivity of the systematic risk that applies to the export coal market to be greater than the market as a whole and therefore greater than unity.

3.6 Gearing

Envestra has been unable to locate any independent empirical analysis on the gearing levels for coal export terminals. We have no reason to believe DBCT Management has over or under stated the benchmark gearing level in their submission.

3.7 Value of Imputation (γ)

When forming their view on the value of imputation credits (i.e.γ= 0.5) Regulators tend to reference a paper by N J Hathaway and R R Officer[20] ('Hathaway & Officer'). There are a number of problems with the Hathaway & Officer paper that require consideration against other objective

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[16] Gray S, (2001) *Issues in Cost of Capital Estimation*, http://www.reggen.vic.gov.au/PDF/2001/SubUQBS_GasPosPapOct01.pdf

[17] Dimson, Marsh and Staunton, *Twelve Centuries of Capital Market Returns*, Business Strategy Review, 2000, Vol 11, Issue 2.

[18] ESC, *Review of Gas Access Arrangement Review – Final Decision*, October 2002, pp361

[19] QCA, Final Decision - Proposed Access Arrangements for Gas Distribution Networks: Allgas Energy Limited and Envestra Limited, pp222

[20] Hathaway, N and Officer, R (1995), The Value of Imputation Tax Credits, Finance and Research Group, Graduate School of Management.

evidence. First, the conclusions reached by Hathaway & Officer are, by their own admission, not precise and have been heavily qualified due to:

i)Simplifying assumptions;

The Hathaway & Officer research discovered that imputation credits for Small Industrial companies were being priced at $0.17 per $1.00 of imputation credit compared to Big Industrials with $0.49 per $1.00 of imputation credit. The Small Industrial result did not concur with Hathaway & Officer's *a priori* expectations. Hathaway & Officer consequently arbitrarily removed the Small Industrial results from their conclusions thereby upwardly biasing the purported value of imputation credits.

ii)The results are applicable only to a specific class of investor. Those investors do not set the cost of capital in the market place.

The value derived for imputation credits is a *conditional valuation* based on *taxable investors,* who are Australian taxpaying individuals, finance companies and superannuation funds. Hathaway & Officer have assumed away the existence and impact of foreign investors on the Australian sharemarket and the cost of capital. Given Australia's small open economy, global capital flows and that securities markets are efficient most of the time[21], foreign investors are the price setting marginal shareholders in the Australian sharemarket. Marginal investors do not become the "average" investors over time and foreign investors place little value on imputation credits. In a subsequent 1998 analysis of the issue R R Officer discusses the appropriate value for imputation credits and concludes that:

> "…*the measurement of gamma is difficult and subject to considerable error and the end result of CSFB adopting a gamma equal to .25 is quite within the bounds of a reasonable estimate.*"[22]

iii) New research supports a gamma close to zero.

Cannavan, Finn, and Gray (2001)[23] 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. 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 value of 0.5.

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[21] Brealey R, Myers S, Partington G, Robinson D (2000) *Principles of Corporate Finance*, 1st Australian edition, McGraw-Hill Australia, pp 369.

[22] R.R.Officer, *Comments on a Report Prepared by Professor Kevin Davis on the WACC for the Gas Industry*, April 8 1998, pp 3.

[23] A copy of this paper accompanies this submission

3.8 Inflation Rate (π)

The mid-point of the Reserve Bank of Australia's 2-3% target range is the most appropriate estimate of the inflation rate.

3.9 Corporate Income Tax Rate (t_c)

The statutory corporate income tax rate is the most appropriate estimate of the corporate tax rate for use in the WACC.

3.10 Asymmetric Risk Factor

The +10% asymmetric risk factor proposed by DBCT is a pragmatic solution to addressing regulatory risk and the truncation of returns arising from the regulatory regime, which is not compensated for in the CAPM. The asymmetric risk factor provides a method consistent with commercial practice to compensate investors for these risks through the regulatory WACC. The Productivity Commission in its *Review of the National Access Regime* highlighted this point:

> *"The potential 'chilling' effect of access regulation on investment in essential infrastructure services is the main concern. Investment may be deterred for two reasons.*
>
> - *Potential exposure to access regulation is likely to increase the general level of risk attaching to investment in essential facilities. The inevitable regulatory discretion involved in the implementation of such regulation, and perceptions that regulatory decisions are likely to be biased in favour of service users, are among the factors that contribute to regulatory risk. These sorts of risks attach to investment in any regulated activity. However, the scale of investment in essential infrastructure, and the fact that, once in place, the assets are 'sunk' with few alternative uses, mean that regulatory risk can be a more critical factor in the investment decision and may sometimes deter projects.*
> - *Investments in essential infrastructure will also be deterred if regulated terms and conditions are not expected to provide a sufficient return. A particular problem here is that the possibility of earning higher than normal profits if a project proves to be very successful may be required to balance the possibility that the project will fail. However, once a facility is operating, it will generally be impossible for regulators to delineate any upside returns from genuine monopoly rent — that is, returns in excess of those necessary to justify the investment. Regulatory pricing arrangements that (inadvertently) appropriate upside returns (so called 'regulatory truncation') can be a significant source of inefficiency arising from access regulation.*
>
> *Third party access and the resulting benefits to service users are only possible over the longer term if there is continuing investment in the essential infrastructure services themselves. On the other hand, while denial or monopoly pricing of access imposes costs on the community, such behaviour cannot threaten the continued availability of the services concerned. This asymmetry in potential outcomes highlights the priority that access regulation must give to ensuring that there are appropriate incentives for efficient investment."*[24]

[24] Productivity Commission, *Inquiry Report – Review of the National Access Regime*, 28 September 2001, pp.XIX

The Value of Dividend Imputation Tax Credits

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ABSTRACT

A dividend imputation tax system provides shareholders with a tax credit that can be used to offset personal tax on dividend income. The size of this credit depends on tax paid at the corporate level so that the "double taxation" of dividends is effectively eliminated. This paper shows how to infer the value of imputation tax credits (which is an important input into the weighted-average cost of capital calculation) from the prices of certain derivative securities that are unique to Australian retail markets. We show that in contrast to conventional wisdom, for large companies with substantial foreign investment the market value of these tax credits is close to zero after recent changes to tax laws that effectively prevent their transfer.

JEL Classification: G31, G38.

Keywords: Dividend imputation, cost of capital.

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ABSTRACT

A dividend imputation tax system provides shareholders with a tax credit that can be used to offset personal tax on dividend income. The size of this credit depends on tax paid at the corporate level so that the "double taxation" of dividends is effectively eliminated. This paper shows how to infer the value of imputation tax credits (which is an important input into the weighted-average cost of capital calculation) from the prices of certain derivative securities that are unique to Australian retail markets. We show that in contrast to conventional wisdom, for large companies with substantial foreign investment the market value of these tax credits is close to zero after recent changes to tax laws that effectively prevent their transfer.

1. Introduction

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 at the statutory corporate tax rate, the shareholder receives the cash dividend plus an imputation tax credit. This tax credit can be used to offset personal income tax obligations.

Almost all developed countries operate some form of dividend imputation. Australia and Germany operate full imputation systems in which all of the corporate tax paid can be offset against personal tax obligations. Many other countries (e.g., U.K., France, Italy, Canada) operate partial imputation systems in which part of the corporate tax paid can be offset against personal tax obligations. In the U.K., for example, the stockholder receives an imputation credit for just under two-thirds of corporate tax paid. Even under a full imputation system, however, not all of the imputation credits can be utilized by stockholders because imputation credits can only be used to offset domestic personal tax obligations. Tax-exempt and non-resident stockholders do not pay domestic personal tax and therefore have no personal tax obligations to offset. That is, different stockholders will place a different value on these imputation tax credits. Tax-paying resident stockholders will value them highly. Conversely, tax-exempt and non-resident stockholders can only extract value from these imputation tax credits if they can somehow transfer them to resident stockholders. A number of schemes have been employed to do this, but in Australia, for example, a recent tightening of tax laws is likely to have increased the costs of performing these transfers.

These issues are of considerable practical importance because, as Officer (1994) demonstrates, the value of imputation credits to the marginal stockholder is an important element in the calculation of a firm's weighted-average cost of capital. In a firm with a mixture of resident, tax-exempt, and non-resident stockholders, it is not clear who is the marginal stockholder and what value they might place on imputation tax credits. In this paper, we use the prices of traded derivatives that are unique to Australian retail markets (where a full dividend imputation system has operated since I July 1987) to infer the value of imputation tax credits. From these derivative prices, we can also infer the value of cash dividends in a way that has some advantages over the standard “drop-off” technique where the value of the dividend is inferred from the ex-date stock price decline.

The textbook approach to estimating the weighted average cost of capital (WACC) is to estimate cash flows after corporate tax and discount them using a WACC that incorporates the effects of corporate taxes (such as any tax subsidy associated with debt financing). Under an imputation system, however, a portion of the taxes paid at the corporate level is really a pre-collection of personal tax. In fact, we demonstrate below that under some circumstances the imputation system effectively eliminates corporate taxes. Resident investors who are subject to domestic personal taxes are effectively taxed at the personal level on their share of corporate profits. The imputation credit attaching to the dividend gives the investor a personal tax rebate for tax that has been paid at the corporate level (this is explained in some detail in Section 2). However, the dividend imputation system does not apply to non-resident investors — they do not receive a rebate for tax paid at the corporate level. That is, not all corporate tax is rebated via the personal tax system. In other words, not all imputation credits can be utilized. The proportion of the imputation credits that can be utilized depends upon the composition of the firm’s shareholder base.

To compute a company’s WACC, we need to know for the marginal investor what proportion of taxes paid at the corporate level is really a pre-collection of personal tax and what proportion really is corporate tax. In this paper, therefore, we seek to estimate the market value of imputation credits for the marginal investor. The WACC can then be estimated either by adding the value of these personal tax payments back into the firm’s cash flows, or by making an appropriate adjustment to the WACC. Officer (1994) illustrates both of these approaches and provides the framework for much of the existing research in the area. The adjustment to the standard WACC calculation takes the following form:

$$r^{*} = r^{e}\left(\frac{1-\tau}{1-\tau(1-\gamma)}\right)\frac{E}{V} + r^{d}(1-\tau)\frac{D}{V}$$

where r^e and r^d denote the cost of equity and the cost of debt respectively; $\frac{E}{V}$ and $\frac{D}{V}$ denote the relative proportions of equity and debt financing respectively; and τ denotes the firm’s marginal tax rate. Within this framework, γ is defined to be the proportion of corporate tax that is really a pre-collection of personal tax for the marginal investor. In this paper, we do not estimate γ directly – rather we seek to estimate the market value of one dollar of imputation tax credits that is actually distributed to the investor. We define the value of this one dollar of imputation tax credits distributed to the investor to be ϕ. These two concepts, γ and ϕ, are the same only if the firm distributes to stockholders 100% of the profits on which Australian company tax has been paid. To see this, suppose that a company distributes only 60% of its "Australian profits" and that all of the company's stockholders can fully utilize all imputation credits that they receive. In this case, the market value of one dollar of imputation credits is one dollar ($\phi=1$) because stockholders can fully utilize every dollar of imputation credits that they receive. But in this case, $\gamma<1$ because not all of the corporate tax has been rebated to stockholders in the form of imputation tax credits. Even though the 40% of retained profits (and the associated imputation credits) may be distributed in the future, there is still a time value loss so that $\gamma<1$. This implies that our estimate of the market value of one dollar of imputation tax credits distributed (ϕ) is an upper bound for γ, and this upper bound is reached only if the firm routinely distributes 100% of its Australian sourced profits. Although we cannot estimate γ directly, we do know that $0<\gamma<\phi$, and since our results indicate that $\phi=0$ we conclude that $\gamma=0$.

To date, there is no general agreement about how to estimate the market value of imputation credits. In this paper we show how to estimate their value using derivative securities that are unique to Australian retail markets. *Individual Share Futures* contracts trade on the Sydney Futures Exchange and *Low Exercise Price Options* trade on the Australian Stock Exchange. These instruments are effectively standard futures contracts written on individual stocks. The implied value of cash dividends and the imputation credits attaching to them can be estimated by comparing the relative prices of these instruments with the underlying stocks. Moreover, our data set allows us to examine the effect of an important tax amendment in 1997 known as "the 45-day rule". This amendment requires that shares must be held for a period of at least 45 days in order to receive imputation credits. It also requires that the holder bear a substantial portion of the risk of owning these shares. That is, if a physical position in shares is hedged with an offsetting derivatives position, the shareholder is unable to claim the imputation tax credit. This new rule is designed to eliminate schemes that provide for the trading of imputation tax credits.

Our analysis indicates that for the marginal investor in the average large Australian firm, cash dividends are valued at their full face value and the value of imputation credits is insignificantly different from zero. However, because different firms have different stockholder bases, an analysis of the "average" firm may be of limited use. Our econometric methodology also allows us to examine a number of individual firms. Four of the largest Australian companies have sufficient data to allow individual estimation. For these four firms, we find that imputation tax credits are essentially worthless, at least after the introduction of the 45-day rule. This is consistent with the fact that these four firms all have a large proportion of non-resident stockholders who, since the introduction of the 45-day rule, are unable to utilize imputation credits. (Or at the very least, the schemes required for non-resident investors to extract some value from imputation tax credits have become more costly to implement since the introduction of the 45-day rule). This contrasts with the results of some earlier research that employs different empirical methods and with the current practice of Australian regulators who routinely use γ=0.5 in rate of return regulation cases.

The remainder of the paper is structured as follows. Section 2 provides an overview of the Australian dividend imputation tax system, stressing the significance of recent changes to taxation laws. Section 3 reviews the relevant literature on the market valuation of dividends with specific emphasis on the value of imputation tax credits. Section 4 shows how individual share futures contacts and low exercise price options can be used to infer the value of imputation tax credits — before and after recent amendments to tax laws. Section 5 presents the empirical results and Section 6 concludes.

2. The Australian Dividend Imputation Tax System

2.1 The Mechanics of the System

In a classical tax system (such as the system operating in the United States), corporate profits are taxed twice, once in the hands of the company and again (if distributed as dividends) at the personal tax rate of the stockholder. Stockholders get no credit at all for tax paid at the corporate level. In contrast, since 1 July 1987, Australia has operated a full imputation tax system such that stockholders can potentially receive a credit for all of the tax paid at the corporate level. In this case, corporate tax (on profits that are distributed) becomes a pre-collection of personal tax.

In particular, stockholders receive a cash dividend plus an imputation tax credit and this bundle is known as a "franked" dividend. This tax credit reflects the amount of corporate tax paid on the source profit from which the dividend was paid. The imputation tax credit can be used to offset Australian personal tax obligations. Thus, these credits are of value to stockholders who are resident natural persons or resident superannuation (pension) funds who have Australian personal tax obligations. However, imputation tax credits are of no direct value to non-resident stockholders who have no Australian personal tax obligations. The detailed mechanics of the Australian dividend imputation tax system are discussed in more detail in the Appendix.

2.2 The Value of Imputation Tax Credits

Officer (1994) shows that for the marginal stockholder a proportion, γ, of the tax collected at the corporate level will be rebated against personal tax and, therefore, is not really company tax but rather is a pre-collection of personal tax. In Table A.1, for example, our representative investor's share of the firm's operating income is \$100. This investor has a marginal personal tax rate of 47%, which gives rise to a personal tax liability of \$47. The company has already paid \$36 of this on behalf of the shareholder, leaving only another \$11 to be paid via the personal tax system. In this case, the entire corporate tax payment of \$36 is treated as a pre-collection of personal tax. It follows (Officer, p.4) that "γ is the proportion of tax collected from the company that gives rise to the tax credit associated with a franked dividend", this credit being utilized to offset the personal tax liabilities of the stockholder.

As noted above, there is a difference between the proportion of corporate tax that is really a pre-collection of personal tax for the marginal investor (γ) and the market value of imputation tax credits that are actually distributed to the investor (ϕ). Since firms may not distribute to stockholders 100% of the profits on which Australian company tax has been paid, $0<\gamma<\phi$. All of the empirical literature in this area estimates ϕ – the value of one dollar of imputation credit that has been distributed. This can then be used as an upper bound for γ, which is what we need for cost of capital calculations.

In this regard, Officer (1994) suggests that we need to estimate value of a dollar of tax credits distributed to the stockholder. But who is *the* stockholder? Superannuation (pension) funds and Australian resident personal taxpayers can fully utilize imputation credits so $\phi=1$ *for* *those stockholders*. If, however, the stockholder cannot utilize the imputation credit, then ϕ = 0 for that stockholder. Examples of stockholders in this category include tax-exempt and non-resident investors.

At the extremes it is a straightforward matter to estimate the value of ϕ for a firm. A firm held solely by tax-exempt and non-resident stockholders could be assumed to have $\phi = 0$ (unless they are able to engage in some scheme to transfer imputation tax credits to resident investors, as we describe below). Conversely, if a firm were solely owned by domestic investors in a high tax bracket, it is reasonable to assume that $\phi = 1$ since imputation credits could be fully utilized. The reality, of course, is that most companies have a stockholder base consisting of a mixture of all these different classes of investors.

Of course imputation credits may be valuable even to non-resident investors if they can be effectively sold to resident individuals and institutions. Evidence of various dividend imputation credit capture schemes leads Officer (1988) to the conclusion that a positive value of franking credits will be capitalized into the price of securities. This is an argument based on the assumption that *all* investors benefit from imputation, either directly by using tax credits to reduce their tax liabilities or indirectly by selling these tax credits to investors who can use them. Officer (1988, p.68) notes "increasing evidence of the ease of tax arbitrage, particularly for overseas investors" and suggests that the "only issue in the sale of a tax credit is how much will the investor lose by way of transactions costs, frictions, etc. of the effective tax credit in setting up vehicles to sell off the tax credit".

The equilibrium price at which franking credits are capitalized will depend upon the cost of setting up and maintaining structures to sell tax credits. Australian tax authorities have introduced a number of measures to prevent channeling or trading in imputation credits, with a view to protecting Treasury revenue. An early amendment to taxation laws eliminated the ability of companies to "stream dividends".[1] Wood (1995) documents a range of dividend plans that allowed investors to choose between franked dividends or unfranked dividends of a higher amount. These schemes were designed to allow franking credits to be channeled to the resident investors who were best able to utilize them.

[1] Taxation Law Amendment Bill (No. 2) 1990.

The elimination of dividend streaming led to the development of new schemes to effectively enable the trading of imputation credits. Listed warrants, for example, were designed to appeal to foreign investors and non-taxable entities. These warrants were typically European-style call options with a nominal exercise price of one cent. They were, in effect, a deferred purchase contract over the underlying share with the buyer making a payment equal to the present value of the share price anticipated for the underlying stock at the warrant's expiry date (less one cent). Since the warrant holder did not have the right to receive dividends paid on the underlying stock until the expiry date, the price paid for the warrant would be reduced by the present value of those expected dividends.[2] The attractiveness of the warrant to foreign investors was that the warrant would be priced with dividends "grossed-up" to reflect the value of imputation credits. According to Wood (1995), this grossed-up rate would typically be around 118% of the cash value of the dividend. This implies that warrant buyers received around 32% of the face value of the imputation credit.[3] Thus foreign investors could effectively receive a fraction of the value of imputation credits by writing these warrants immediately before an ex-dividend date and buying-to-close immediately after.

Arrangements temporarily transferring share ownership around ex-dividend days were also constructed. Partington and Walker (1999) cite the example of an Australian resident corporation agreeing to "purchase" a share cum-dividend from its overseas owner thereby receiving the dividend and associated franking credit. The share is then returned to its original owner ex-dividend in addition to 105% to 110% of the dividend, which implies that imputation credits are valued at between 9% and 18% of face value. This arrangement eliminates the price risk involved in the simple strategy of selling the share in the market prior to the close of cum-dividend trading and then repurchasing upon the share going ex-dividend.

[2] If the total amount of dividends paid on the underlying stock was different from the projected dividends priced in originally, adjustments were made. If the total dividends were less than expected the exercise price was increased by the amount of the deficiency, if the dividends were larger than expected the excess was added to the underlying parcel at the expiry date.

[3] At a 36% tax rate, an imputation credit of 0.36/(1-0.36) = 0.56 would attach to each dollar of cash dividends paid. The cash dividend plus 32% of the face value of the imputation credit is therefore 1 + 0.32(0.56) = 1.18.

2.3 Measures to Prevent the Trading of Imputation Tax Credits

Tax arbitrage schemes have the effect of increasing the value of imputation tax credits to investors who are unable to utilize them directly. They also have the effect of eroding Treasury revenue as more imputation tax credits are utilized. The Australian government responded to the various schemes in place, claiming that transactions involving the transfer of franking credits without the economic risks of share ownership brought into question the affordability of the imputation tax system.[4] 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.

These measures were deemed to be effective from 1 July 1997 even though the bill was not passed into law until some time after the announcement. The significant strengthening of the laws relating to imputation tax credits chiefly concerned the imposition of a 45-day minimum holding period. Unless a share is held for forty-five days around the date of dividend entitlement, investors do not qualify for franking credits. In determining whether shares 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.[5]

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 allow our estimates of the market value imputation credits to differ before and after the introduction of the 45-day rule.

3. Inferring the Market Value of Dividends

3.1 General

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. Early research by Campbell and Beranek

[4] From Treasurer's Press Release No. 89 as cited in Partington and Walker (1999).

[5] Delta (the ratio of change in the price of the net position to the change in the price of the underlying stock) is used as the measure of the net equity risk. If the delta of the position in question is less than 0.3 the arrangement violates the 45-day rule. Thus a "substantial" hedge is one that eliminates more than 70% of the price risk.

(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. The *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. That is, the existence of a tax-related dividend premium, whereby the share price falls on the ex-dividend day by less than the dividend amount, is often cited as being consistent with a preference for capital gains at the margin.

The *tax clientele hypothesis* posits that shareholders with higher marginal tax rates on dividends prefer to invest in firms that retain more of their profits and thereby offer higher capital gains, while shareholders with lower marginal tax rates prefer to invest in firms that distribute a higher proportion of their profits as dividends. It predicts, accordingly, that a stock's drop-off ratio increases with its dividend yield. Elton and Gruber (1970) report an average drop-off ratio of 0.78 (the tax differential effect) and a direct relationship between the drop-off ratio and the dividend yield (the clientele effect).

This result is questioned by Kalay (1982) who 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. In response, Elton, Gruber, and Rentzler (1984) argue that Kalay (1982) ignores some transaction costs, which largely restrict short-term traders from dominating ex-dividend price setting. Consequently they argue that ex-dividend price behavior is likely to be determined by long-term trading, as the restrictive no-profit bounds were far greater than those suggested by Kalay. The implication is that the ex-dividend drop-off lies within the no-profit range and is therefore driven by tax considerations. The relevance of transaction costs continued to be contentious, with Kalay (1982) reporting less restrictive bid-ask spreads for frequently traded shares and emphasizing that transaction costs are less relevant for investors who are liquidity traders or who, at the margin, can avoid some costs of trading. Michaely (1991) also presents evidence consistent with ex-dividend day drop-offs being driven by short-term dividend capture strategies associated with arbitrage activity.

The effect of the introduction of the US 1984 Tax Reform Act ("the Act") is particularly instructive, as it is similar to the dividend trading restrictions proposed in the 1997 Australian budget. The Act increased the required holding period to 46 days before any tax exemptions could be claimed on dividends received and was specifically designed to increase the risk of trading on shares going ex-dividend. Grammatikos (1989) reports evidence of dividend capture trading but suggests that the holding period requirement of the 1984 Tax Reform Act increased the risk exposure of a short-term trader finding that the average market-adjusted ex-dividend day return after the introduction of the Act was significantly higher than before the Act. This evidence suggests that the Act had the desired effect with the increased risk that must be undertaken to capture the dividend meaning the positive return is no longer as attractive. The significant change in the ex-dividend day return was most profound in high-yielding stocks, consistent with these being the stocks on which short-term traders would focus their activities.

Porterba and Summers (1984) provide evidence from the UK. In contrast to Grammatikos (1989) they find that the introduction of ex-dividend day trading restrictions under the 1970 Finance Act did not lead to any changes in ex-dividend day yields. The introduction of a partial imputation system in 1973 was found to permanently reduce the return on the ex-dividend day providing evidence consistent with the tax differential hypothesis.

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, one-for-one marginal price drop has been an excellent (average) rule of thumb." We further develop this equilibrium framework in a dividend imputation setting and find results that are consistent with this.

3.2 Australian Literature

Brown and Walter (1986) study the ex-dividend behavior of shares 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 share 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 tax credits of between 77 and 82 cents. 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%, 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.

3.3 The Limitations of Traditional Ex-Dividend Research Techniques

The early empirical research into the value of tax credits suffers from a number of 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.[6]

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,

[6] Brown and Clarke (1993) at p.34 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. This potential multicollinearity problem, and methods for dealing with it, are described in Section 5.

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.

The third problem is that the estimation approach typically assumes that the value of tax credits does not vary over the sample period and is constant across companies in the sample. Wood (1995) makes this point and argues that both assumptions may be invalid. He also highlights the debate in the literature as to whether these ex-dividend day studies can provide estimates of the *normal* equilibrium value of dividends (or tax credits). Short-term arbitrageurs' trading around ex-dividend dates may result in prices being inferred for franking credits (and dividends) that are different from the equilibrium price of all future franking credits incorporated in the market prices of equity. The effect of tax rule restrictions and differential transaction costs can result in trading around ex-dividend dates being driven by short-term traders rather than the marginal stockholder in the firm who ultimately sets equilibrium stock prices. In this paper, we examine the valuation of dividends over a longer period (not just around the ex-date) so it is less likely that the valuation of dividends reflects short-term traders' actions.

The fourth problem is that microstructure effects make dividend drop-off results difficult to interpret. Frank and Jagannathan (1998) demonstrate that the dividend drop-off in the Hong Kong market is less than the dividend amount, even though there is no tax on dividends or capital gains. They attribute this to the effects of the 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.

For these reasons, it is unlikely that the traditional ex-dividend day drop-off methodology will be able to separately identify the value of cash dividends and imputation credits. An alternative framework is to imply these values from the prices of traded financial instruments.

This approach has been adopted in a classical taxation system by Barone-Adesi and Whaley (1986) who estimate the implied value of dividends from call options. They simultaneously estimate the implied volatility and the implied value of dividends using traded option prices and the Roll-Geske-Whaley model for American call options. They find that these cash dividends are valued at their full face value. This approach has the advantages that (i) there are many more observations available (every option trade provides another observation, whereas the dividend drop-off methodology generates only a single observation per dividend event), and (ii) estimates can be generated using option trades a month or more before the dividend event, before any short-term arbitrage activity may have started. The disadvantages of this approach is that there are two parameters that need to be simultaneously estimated, and estimates are based on a particular option pricing model.

McDonald (2000) infers the market value of German dividend imputation credits by examining price changes in German stocks around dividend payments. He also compares the relative values of the DAX 30 stock index and the associated futures contract. He also develops a costly-arbitrage model in the spirit of Boyd and Jagannathan (1994) to characterize an equilibrium since investors are heterogeneous with respect to the value of imputation credits. He concludes that for the average firm in the index, the value of the imputation credit to the marginal investor exceeds half its face value. We follow this approach of developing an equilibrium framework and then inferring the value of cash dividends and imputation credits from the relative prices of stock and futures prices. Twite and Wood (1997) also use a similar approach to estimate the value of grossed-up dividends (the cash dividend plus the imputation credit) by examining the relative prices of stocks and futures contracts. In the following section, we further develop and extend this framework.

4. Data Description and Valuation Framework

In this section we illustrate how the value of dividend imputation tax credits can be inferred from two types of derivative securities that are unique to Australian retail markets.

4.1 Individual Share Futures Contracts

Individual Share Futures (ISF) contracts are traded on the Sydney Futures Exchange (SFE) and written with (typically) 1,000 shares of an individual company as the underlying asset. They are not protected against dividend payments. The contract calls for settlement to be made in cash at a price derived by averaging SEATS[7] bid and ask quotations of the share on a minute by minute basis over the last two hours of trading before expiry. The contract has a quarterly maturity cycle, with at least two delivery contracts quoted at any one time. The SFE began trading ISF contracts on 16 May 1994. At that time, trading was limited to contracts on the shares of BHP Ltd., The National Australia Bank, and News Corporation. ISF contracts now trade on eleven of Australia's largest companies.

4.2 Low Exercise Price Options

In 1995, the Australian Stock Exchange (ASX) introduced an instrument to compete with the individual share futures contracts trading on the rival Sydney Futures Exchange. Low Exercise Price Options (LEPO's) are similar to standard exchange-traded call options in that they give the holder the right to purchase 1,000 shares in a company at a pre-determined price and impose an obligation upon the writer of the LEPO to sell those shares at the exercise price if the option is exercised. However, LEPO's have a nominal exercise price of one cent, so they are always deep in the money. Moreover LEPO buyers are not obliged to pay for the option in full, but are instead required to deposit an initial margin with the exchange and all positions are marked-to-market daily. This effectively transforms the option into a futures contract *identical* to the ISF, except that the one-cent exercise price must be paid to exercise the option at expiry. LEPO's now trade on 29 large Australian companies.

4.3 Contract Valuation

In this section we use the standard cost-of-carry no-arbitrage framework to derive a valuation formula for ISF's and LEPO's. One element of this valuation will be the anticipated stock price decrease on an ex-dividend day. We therefore consider a "representative investor" who faces the same marginal tax rate of τ_p on dividend income, income from futures trading, and short-term capital gains on stocks, which is effectively the case in the Australian market. For Australian resident individuals and institutions, imputation credits are treated as ordinary income and taxed at τ_p (as explained in the appendix). For non-resident investors, however, tax on dividend income is paid in the country of residence and imputation credits cannot be

[7] The Stock Exchange Automated Trading System (SEATS) is the computer network trading system through which all stocks are traded on the Australian Stock Exchange.

used and are therefore not taxed in Australia. Finally we make the assumptions necessary to treat a futures contract as a forward contract as in Cox, Ingersoll, and Ross (1981).[8]

We seek to value a contract at time t where the contract matures at time T. We define $F_{ij}(t,T)$ to be the futures price at time t for a contract over stock i and dividend j that matures at time T. $S_{ij}(t)$ is the spot price of the underlying stock i at time t that pays dividend j. $D_{ij}(s)$ and $IC_{ij}(s)$ are the dividend payment and imputation credit, respectively, for stock i and dividend j at the ex-dividend date s, ($t<s<T$) which is assumed known at time t. We define X to be the exercise price, so $X = 0$ for the ISF's in our sample and $X = 0.01$ for LEPO's. Finally, r is the continuously-compounded risk-free rate of interest.

Within the standard no-arbitrage framework, we show that there are two ways to obtain ownership of one share at time T. Since both methods require a single net cash flow at time T, the amount of this net cash flow must be the same for both methods or arbitrage is possible.

Method 1: Forward Contract

Under this method, the individual buys a forward contract on the stock at time t. This contract does not entitle the individual to the dividend or the imputation credit at time s. At time T the contract matures and the individual pays the already agreed upon $F_{ij}(t,T)$, and the strike price X, and receives one share that can be sold for $S_{ij}(T)$ at that time. The forward contract is actually cash settled, so the investor does not physically receive the share. Thus the only transactions costs that are involved are a round trip transaction cost on the futures contract, the time T value of which is c_F. The trading profit is taxed at the rate of τ_p so the net cash flow at time T is:

$$\left(S_{ij}(T) - \left[F_{ij}(t,T) + X + c_F\right]\right)\left(1 - \tau_p\right).$$

Method 2: Physical Replication

[8] The price of a futures contract is equal to the price of an equivalent forward contract under certain assumptions: (1) no transactions costs, (2) borrowing and lending interest rates are equal and non-stochastic, (3) margin calls are settled at the end of each period between buyers and sellers, (4) investors do not default on any contract, and (5) the payoff from investing the proceeds from short sales at the risk-free interest rate is received when the futures contract matures.

Under this method, the individual borrows $S_{ij}(t)$ and buys one share at time *t*. At time *s*, the individual receives a cash dividend of $D_{ij}(s)$ and an imputation credit of $IC_{ij}(s)$. The cash dividend can be placed in an interest-bearing account and will have grown to $D_{ij}(s)e^{r(T-s)}$ at Time *T*. This dividend, plus the accumulated interest is taxed at τ_p so the investor is left with $D_{ij}(s)e^{r(T-s)}(1-\tau_p)$ after taxes. At Time *T*, the investor potentially extracts some value from the imputation credit. In particular, the investor extracts $\$\phi$ in value from every one dollar of imputation credits and pays tax on this.[9] Thus, the after-tax value of the imputation credit is $\phi IC_{ij}(s)(1-\tau_p)$. At Time *T*, the investor must repay the original loan plus interest which amounts to $S_{ij}(t)e^{r(T-t)}$. Of course, the interest component of this loan is tax deductible, so the after-tax payment required to extinguish the loan is $S_{ij}(t)e^{r(T-t)} - S_{ij}(t)(e^{r(T-t)}-1)\tau_p$. Finally, the investor can sell the share for $S_{ij}(T)$ and pay capital gains tax of $(S_{ij}(T)-S_{ij}(t))\tau_p$ since capital gains are effectively taxed as ordinary income over our sample period. This strategy involves a round trip of transactions costs on the stock plus the transactions costs associated with borrowing, which are jointly defined to have a time *T* value of c_S. A little algebra shows that the net after-tax payoff to this strategy at Time *T* is:

$$\left(S_{ij}(T) - \left[S_{ij}(t)e^{r(T-t)} - D_{ij}(s)e^{r(T-s)} - \phi IC_{ij}(s) + c_S\right]\right)(1-\tau_p).$$

Since the net payoff from Method 1 must equal the net payoff from Method 2 to prevent arbitrage, it must be the case that:

$$F_{ij}(t,T) + X + c_F = S_{ij}(t)e^{r(T-t)} - D_{ij}(s)e^{r(T-s)} - \phi IC_{ij}(s) + c_S$$

which gives us a valuation formula for the forward contract:

$$F_{ij}(t,T) = S_{ij}(t)e^{r(T-t)} - D_{ij}(s)e^{r(T-s)} - \phi IC_{ij}(s) - X + (c_S - c_F). \qquad (1)$$

[9] Note that ϕ represents the value of a dollar of imputation credits paid to the investor. Recall that this differs from γ (as discussed in Section 2) in that γ represents the value of a dollar of imputation credits available to be paid out. The two will only be equal if the company pays out all of its available imputation credits. If not, then $\gamma < \phi$ due to the loss of time value. A non-resident investor may be able to sell one dollar of imputation credits for $\$\phi$ and would then have to pay tax on this.

Finally, note that if we repeat this analysis for a seller rather than a buyer, the sign on the transaction cost term will reverse. This gives us an expression for the value of the futures contract in terms of the spot price of the underlying stock and the value that the representative investor obtains from cash dividends and imputation credits, bounded by transaction costs:

$$\begin{aligned} S_{ij}(t)e^{r(T-t)} - D_{ij}(s)e^{r(T-s)} - \phi\, IC_{ij}(s) - X - (c_S - c_F) \\ < F_{ij}(t,T) < \\ S_{ij}(t)e^{r(T-t)} - D_{ij}(s)e^{r(T-s)} - \phi\, IC_{ij}(s) - X + (c_S - c_F). \end{aligned} \tag{1a}$$

In Section 5 we exploit this relationship with a unique data set to infer the relative values of cash dividends and imputation credits.

4.4 Data Description

ISF data is available from May 1994 (when the SFE commenced trading in ISF contracts) to December 1999 and LEPO data is available from April 1995 (when LEPO trading commenced on the ASX) to December 1999. Trades in the contracts and the underlying stocks were obtained from SIRCA.[10] At any point in time, only the nearest-to-maturity contract has any liquidity, so instances of maturities more than six months are rare. We do, however, ensure that observations with more than one dividend before maturity are eliminated from the sample. Moreover, much of the liquidity is in the four largest companies. Every futures trade is matched to the nearest trade in the underlying stock and included in the sample if the trade in the underlying stock occurs within a five-minute interval of the futures trade. LEPO trades are excluded from the sample if they have a special comment accompanying them that indicates that the trade is a crossing or that there is something "special" about them that indicates that the price of the trade could not be regarded as market-determined. The sample includes fully franked, partially franked, and unfranked dividends. SIRCA also provides data on dividend amounts, franking, ex-dates, and announcement dates.

[10] Securities Industry Research Centre of the Asia-Pacific is an industry-sponsored financial markets research center consisting of a consortium of Australian universities. SIRCA receives a direct feed from the Australian Stock Exchange and the Sydney Futures Exchange and provides this data without screening or any adjustment. A small number of observations are erroneous, with the most common errors being misplaced decimal points and transcription errors. To ensure that these observations do not enter our data set, we compare all prices with daily open-high-low-close summaries provided by the exchanges. We exclude any observation for which the price falls outside the daily high-low range reported by the exchange. This results in less than 0.1% of the observations being excluded.

Our primary analysis assumes that dividend information is known at the time the futures trades, but we also repeated the analysis for the subset of observations for which the dividend had already been announced. This significantly reduces the sample size, but does not substantially change any of our results. The reason for this is that dividend amounts and franking percentages are relatively predictable[11]. The dividend yield ranges from 0.129% for News Corporation (NCP) to 3.901% for Pacific Dunlop (PDP), where this is a yield per dividend not per year (most Australian companies pay two dividends per year).

Proxies for the risk-free rate of return are obtained from the Reserve Bank of Australia (RBA). Specifically, the daily values for the RBA 11.a.m. Cash Rate, the RBA 30-Day Dealers Bill Rate, the RBA 90-Day Dealers Bill Rate, and the RBA 180-Day Dealers Bill Rate are obtained for the sample period. Interest rates are chosen to match, as closely as possible, the time until the dividend payment or contract maturity. If the relevant number of days is 15 or less we use the cash rate, if there are between 16 and 60 days we use the 30 day rate, and so on.

5. Econometric Methods and Results

5.1 Econometric Method

We begin by testing the accuracy of our cost-of-carry no-arbitrage valuation formula in the absence of dividends. To do this, we collect every trade of ISF and LEPO contracts in our sample for which there is no dividend prior to maturity of the contract. In the absence of dividends and transactions costs, Equation (1) reduces to:

$$F_{ij}(t,T) = S_{ij}(t)e^{r(T-t)} - X \ .$$

We then compute the relative pricing error, which in the absence of dividends and transactions costs, is defined as:

$$RPE_{ij}(t) = \frac{S_{ij}(t)e^{r(T-t)} - X - F_{ij}(t,T)}{S_{ij}(t)} .$$

[11] One exception to this is the December 1999 dividend for National Australia Bank which is the only dividend of the last 31 that is not fully franked. We discuss this in some detail below.

The mean value of the relative pricing error is around 0.01%. This is economically insignificant given that transactions costs on stocks are around 0.3% of the stock price at a minimum. Even if transactions costs were zero, the magnitude of any arbitrage opportunity is very small. The mis-pricing on a $25 stock, for example, amounts to a quarter of a cent per share. Therefore, on average the pricing of ISF and LEPO contracts, with no intervening dividend payment to maturity, is consistent with the no-arbitrage pricing relationship established in Equation (1).

Figure 1, a histogram of the pricing errors expressed as a percentage of the stock price, shows that the majority of pricing errors lie within one half of one percent of zero. There are very few instances of the ISF or LEPO contracts being under-priced or over-priced by more than 2% of the stock price. These results provide additional support confirming that the pricing of both ISF and LEPO contracts is consistent with the Equation (1) no-arbitrage pricing relationship.

[FIGURE 1 ABOUT HERE]

Straight substitution of the Relative Pricing Error into our no-arbitrage valuation formula in Equation (1a) yields:

$$RPE_{ij}(t) = \beta_0 + \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \phi \frac{IC_{ij}(s)}{S_{ij}(t)} \tag{2}$$

where β_0 represents an equilibrium average transaction cost differential, which we discuss in more detail below. It is this representation in Equation (2) that forms the basis of our empirical tests. In particular, we form a regression model:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \beta_2 \frac{IC_{ij}(s)}{S_{ij}(t)} + \varepsilon_{ij}(t). \tag{3}$$

β_1 measures the value of one dollar of cash dividends relative to the value of one dollar of futures payoff. Note that this differs from the interpretation in dividend drop-off studies, which estimate the value of dividends relative to capital gains, rather than futures payoffs. Because both these forms of income are taxed at the same rate, Equation (1a) suggests that we should expect $\beta_1 = 1$. β_2 measures the value that the representative investor obtains from receiving one dollar of imputation credits.

During our sample period, personal tax rates on dividend income remained constant (in nominal terms), but the introduction of the 45-day holding period rule (described in Section 3) potentially reduces the value of imputation credits. For this reason, we allow the value that the representative investor obtains from imputation credits to change when the new rule took effect on 1 July 1997. We do this by introducing a dummy variable into our regression model:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \beta_2 \frac{IC_{ij}(s)}{S_{ij}(t)} + \beta_3 \, DUM(t) \frac{IC_{ij}(s)}{S_{ij}(t)} + \varepsilon_{ij}(t) \qquad (4)$$

where $DUM(t) = 0$ for trades prior to 1 July 1997 and $DUM(t) = 1$ for trades after that date. Recall that β_1 measures the value of one dollar of cash dividends relative to the value of one dollar of futures payoff, and this is assumed to be unaffected by the tax law changes. β_2 measures the implied value of one dollar of imputation tax credits prior to the introduction of the holding period rule, and β_3 measures the change in the implied value of one dollar of imputation tax credits caused by the introduction of the holding period rule. Hence $\beta_2 + \beta_3$ measures the implied value of one dollar of imputation tax credits since the change in the tax laws. The intended effect of the holding period rule is to decrease the value of imputation tax credits. That is, $\phi = \beta_2$ before the 45-day rule and $\phi = \beta_2 + \beta_3$ after.

Finally, note that for unfranked dividends there are no imputation credits, so Equation (4) reduces to:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \varepsilon_{ij}(t). \qquad (4a)$$

5.2 Equilibrium Considerations

Boyd and Jagannathan (1994) and McDonald (2000) construct equilibrium models for ex-dividend stock pricing. They do this by considering (i) several different classes of investor, and (ii) buyers and sellers within each class. For every type of trader, they construct an indifference curve on which the trader is indifferent between trading cum-dividend and ex-dividend. These indifference curves vary across investors according to whether they are buyers or sellers, the transactions costs they face, and the differential between the taxes they face on dividends and capital gains. The next step in characterizing the equilibrium is to eliminate any region that would admit arbitrage for any class of investors. Arguments are then made about where, within the admissible range, market-clearing prices might lie and these predictions are tested empirically.

In this section, we follow a similar strategy in constructing an equilibrium model. In our model, however, we are not considering the choice of trading cum- versus ex-dividend. Rather, we examine the choice of trading in the physical stock or in the futures. Whereas the existing literature plots indifference curves in terms of the ex-dividend price drop, we consider the difference between simultaneous stock and futures prices.

We begin by considering a buyer who, at Time t, decides to have ownership of the stock at Time T, where $T > t$. There are two ways to do this – buy the futures that matures at T, or borrow and buy the stock now. Equation (1) gives a futures price at which the buyer will be indifferent between these two alternatives. Rearranging this expression and scaling by the current stock price suggests that the potential buyer is indifferent between stock and futures so long as:

$$\frac{S_{ij}(t)e^{r(T-t)} - F_{ij}(t,T) - X - D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} = \frac{-(c_S - c_F)}{S_{ij}(t)} + \phi \frac{IC_{ij}(s)}{S_{ij}(t)}.$$

In this expression, the left-hand side is the relative basis that is not explained by the time value of money or dividends. The first term on the right-hand side involves the excess of proportional stock transactions costs over futures transactions costs.

Discussions with traders suggests that a reasonable estimate for this term is in the order of 1%. Recall that under our replication strategy c_F includes half the futures bid-ask spread plus commission on a single futures trade and c_S includes the cost of setting up a loan, the full stock bid-ask spread, and a round trip of commissions on the stock.

The final term in this expression is the imputation credit "yield". Note that this expression holds for *all* buyers. What differs across buyers is the transaction cost differential that they face and the value they place on imputation credits. For Australian taxpaying individuals, resident pension funds, and market makers imputation credits can be fully utilized so $\phi=1$. Non-resident investors may be able to extract some value from the imputation credits, but the necessary procedures will be costly, so for them $\phi<1$.

Using similar logic, potential sellers will be indifferent between trading in the stock and futures so long as:

$$\frac{S_{ij}(t)e^{r(T-t)} - F_{ij}(t,T) - X - D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} = \frac{(c_S - c_F)}{S_{ij}(t)} + \phi \frac{IC_{ij}(s)}{S_{ij}(t)}.$$

These stock/futures indifference curves, for different types of investors, are illustrated in Figure 2. In all cases the intercept represents the relative transaction cost differential and the slope of the line is the value that the investor places on one dollar of imputation credits, ϕ. Figure 2 is drawn with $\phi=1$ for domestic investors and $\phi=0$ for foreign investors (which is the intention of the legislation). Note that if foreign investors are able to extract partial value from imputation credits, the foreign investor indifference lines would be upward-sloping and the feasible equilibrium region would become slightly smaller. The horizontal axis in Figure 2 is the imputation credit yield, $\frac{IC_{ij}(s)}{S_{ij}(t)}$ and the vertical axis is the relative difference between stock and futures prices that is not explained by the time value of money or cash dividends, $\frac{S_{ij}(t)e^{r(T-t)} - F_{ij}(t,T) - X - D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)}$. In the upper part of the figure, the futures is relatively undervalued and in the lower part of the figure the futures is relatively overvalued.

[FIGURE 2 ABOUT HERE]

Consider the indifference line for the non-resident (foreign) buyer (FB). The intercept is negative, which reflects the fact that this investor would prefer to trade in the futures (because it is cheaper) but would trade in the stock if the price were cheap enough relative to the futures (i.e., low enough to more than offset the additional transactions costs). The figure is drawn with a slope of zero, which would be the case if the foreign investor were unable to extract any value from imputation credits. For a foreign seller (FS) the intercept is positive, which reflects the fact that this investor would prefer to sell the futures (because there are lower transactions costs) but would sell the stock if it were overvalued enough relative to the futures. The line "FS arb," which reflects a round trip transaction cost on both the stock and the futures, with intercept $\frac{(c_F + c_S)}{S_{ij}(t)}$, indicates an arbitrage boundary for a foreign investor – at any point above this line, a foreign investor can execute an arbitrage by buying futures and selling stock.

In Figure 2, tax-paying domestic buyers (DB) and sellers (DS) face the same transaction costs as foreign investors, but are able to extract full value from imputation credits. The line "DB arb," which reflects a round trip transaction cost on both the stock and the futures, indicates an arbitrage boundary for a domestic investor – at any point below this line, a domestic investor can execute an arbitrage by buying stock and selling futures.

Domestic market makers can be thought of as having marginal transactions costs of zero and as being unable to utilize imputation tax credits. This is because the 45-day rule prevents them from claiming imputation credits if they hold an offsetting (hedging) futures position. Thus, the indifference curve for domestic market makers lies along the horizontal axis of Figure 2. For this reason, the role of the market maker is much less important in our analysis of stocks/futures than in the analysis of cum/exercise-dividend equilibrium in Boyd and Jagannathan (1994) and McDonald (2000).

In characterizing the equilibrium, we begin by ruling out any region that admits arbitrage for any class of investors. That is, we rule out any point above FS arb or below DB arb. This leaves the shaded region in Figure 2 as the feasible equilibrium region.

This feasible region is broken into five smaller areas and the types of traders who are active in trading the futures in each area are listed in Table 1. Area E, for example, falls below the DB and FB lines and so both domestic and foreign buyers would prefer to buy physical stock rather than the (relatively overpriced) futures. For similar reasons, there will be a lack of sellers of the futures contracts in Area D. This restricts our feasible region to Areas A, B, C, and F. In Area A, which corresponds to smaller dividends, all types of traders are active. For larger dividends, Areas B, C and F will be relevant. In Area B, there are domestic and foreign sellers and only foreign buyers. In Area C, there are only domestic sellers and domestic and foreign buyers. In Area F there are foreign buyers and domestic sellers.

[TABLE 1 ABOUT HERE]

Next, we follow Boyd and Jagannathan (1994) in using information from other research about the relative size of positions taken by various classes of investor. Boyd and Jagannathan, for example, use market information about the large long positions taken by dividend capturers to infer where, within their feasible equilibrium region, the actual equilibrium is likely to lie. In this case, we use information supplied by ISF market makers that suggests that the sell side of this market is dominated by hedging demand from institutional investors (both domestic and foreign). The buy side of this market is dominated by foreign institutions who use the ISF's as a cost-effective way of gaining exposure to the Australian market.[12] This suggests that we would see observations in Area B rather than Area C. For a relative transactions cost differential of 1%, Area F corresponds only to imputation credit yields in excess of 2%. At a 36% corporate tax rate, this requires the yield for an individual dividend to exceed 3.5%. Since dividends of this magnitude do not appear in our sample, we do not observe any data points in Area F. Ultimately, of course, the distribution of observations in Figure 2 is an empirical question. If prices are ultimately set by foreign buyers, we would see many observations in Areas A and B, and we would expect the slope of our regression line (ϕ) to be low, commensurate with the value that foreign investors place on imputation credits. Conversely, if prices are ultimately set by domestic sellers, we would see many observations in Areas A and C, and we would expect the slope of our regression line (ϕ) to be close to one, commensurate with the value that domestic investors place on imputation credits.

[12] One common strategy, for example, is for a fund that is benchmarked against a world or regional index to take a long futures position commensurate with an increase in funds under management and then trade out of the futures and into physical stock over time. This reduces tracking error for the fund without causing the fund to bear the liquidity costs of having to invest immediately in the physical stocks (the benchmark index in the Australian market is extremely broad and includes many small stocks).

5.3 Results

[TABLE 2 ABOUT HERE]

Table 2 provides the results of our regression model in Equation (4). The columns labeled "All Dividends" are based on all observations for which there was no dividend prior to maturity plus all observations for which there was a franked or unfranked dividend. Observations for which there is no dividend help to tie down the intercept, β_0, unfranked dividends help to tie down the value of cash dividends, β_1, and franked dividends help to tie down the value of imputation credits, β_2 and β_3. In the column labeled "Unfranked Dividends Only" we omit from the sample all observations for which there was a franked dividend.

According to our valuation framework, β_0 represents an equilibrium average transaction cost differential and our estimate is insignificantly different from zero in both statistical and economic terms. This is to be expected if futures trades are both buyer- and seller-initiated. If this is the case, we would expect to see observations plotting all throughout Area A in Figure 2 and this would produce an intercept close to zero. If, for example, trades were overwhelmingly seller initiated, we would expect more observations at the top of Area A and a positive intercept.

β_1 measures the value of one dollar of cash dividends relative to the value of one dollar of futures payoff, with an expectation that $\beta_1 = 1$ because both are taxed in the same way as ordinary income. Whether we include all dividends in our sample or restrict our analysis to unfranked dividends (which are treated in exactly the same way as a cash dividend in the US), the estimate of β_1 is insignificantly different from one. This suggests that the representative investor places the same value on a dollar of dividends as on a dollar of futures payoff. Note that our approach measures the value of cash dividends relative to futures payoffs, rather than capital gains, and is therefore not directly comparable to estimates from U.S. studies. Moreover, we use contemporaneous trades of stocks and futures rather than dividend drop-offs. Therefore, the microstructure-based explanations of why cash dividends might *appear* to be valued less than capital gains do not apply in our setting (see Frank and Jagannathan, 1998 and Bali and Hite, 1998). In this respect, our setting is much more analogous to Barone-Adesi and Whaley (1996) and McDonald (2000), who back out the implied value of cash dividends from derivatives prices.

The estimate of β_2 is 0.10, but this is insignificantly different from zero. This result is consistent with the representative investor being a foreign investor who can extract an insignificant amount of value from imputation credits by transferring them to domestic tax-paying investors. It is inconsistent with the representative investor being a domestic tax-paying investor who can fully utilize imputation credits. However, this is an average across all companies in our sample and we prefer to focus on the company-by-company analysis below.

The estimate of β_3 alone is negative and statistically significant. This is consistent with the introduction of the 45-day rule having a significant effect in reducing schemes that allow non-resident investors to "sell" imputation credits. We also test whether $\beta_2+\beta_3$ (the value of imputation credits after the 45-day rule) is significantly different from zero by comparing this unrestricted model with a model in which this restriction is imposed. The results of this restricted model are reported in the second column of Table 2 and as an *F*-statistic and *p*-value for $\beta_2+\beta_3=0$, and suggest that the restriction is not significant. That is, we cannot reject the hypothesis that imputation credits are worthless before ($\beta_2=0$) or after ($\beta_2+\beta_3=0$) the 45-day rule. Moreover, the restricted model fits the data as well as the unrestricted model (in terms of R^2) and confirms the full value of cash dividends ($\beta_1=1$).

All of these results relate to the average company in our sample and may be difficult to interpret since different companies have different shareholder bases and potentially marginal investors with different taxpaying positions. Unlike earlier studies, our methodology allows us to estimate the value of imputation credits for individual firms, and this is the primary focus of our results. Our sample includes four companies for which there are sufficient observations for a separate analysis — BHP (mining and steel), Rio Tinto (mining), National Australia Bank, and ANZ Banking Group. For each of these companies we separately estimate the regression model in Equation 4 and report the results in Table 3.

For some individual companies, multicollinearity can be a concern. In the extreme case where a company paid only fully-franked dividends and the corporate tax rate was constant, the first two independent variables in Equation 4 would be perfectly collinear. In this case, the value of cash dividends (β_1) and imputation credits (β_2) cannot be separately identified. If, however, we *impose* a value for cash dividends, we can then reliably estimate the value of imputation credits (conditional on that value for cash dividends). Therefore, Table 3 also includes estimates of the value of imputation credits conditional on cash dividends being valued at 100% relative to futures payoffs (which is the value of cash dividends, β_1, for the average company in Table 2, and is also consistent with expectations given that dividends and futures payoffs are both taxed in the same way). Finally, we note that if a company pays a mixture of franked and unfranked dividends, the multicollinearity will be broken, enabling separate identification of the cash dividends (from the unfranked dividends) and imputation credits (from the franked dividends). In the last row for each company, we estimate the value of cash dividends from unfranked dividends only (where there are sufficient observations). In all of our analyses, we also include observations for which there was no dividend prior to maturity as these observations help to tie down the intercept, β_0. A number of summary statistics for each firm are documented in Table 4. These statistics relate only to those observations for which there was a dividend prior to maturity. For all of our companies there is a broad range of times to maturity and times to dividends.

[TABLES 3 AND 4 ABOUT HERE]

For BHP, cash dividends appear to be fully valued relative to futures payoffs. In the first row of Table 3, β_1 is insignificantly different from one. This is confirmed when we restrict the sample to unfranked dividends in the final row for BHP. Moreover, the results in the first row suggest that imputation credits are worthless before and after the introduction of the 45-day rule since β_2, β_3, and $\beta_2+\beta_3$ are all insignificantly different from zero. We are confident that the potential multicollinearity problem described above has not affected these results. This is because the value of cash dividends (β_1) is essentially the same whether we use the whole sample or the sub-sample of unfranked dividends. Once the value of cash dividends has been tied down, the value of imputation credits can be reliably estimated. What breaks the multicollinearity here is the fact that about a quarter of the dividend observations are unfranked dividends and these tie down a sensible estimate for the value of cash dividends.

The results for Rio Tinto clearly demonstrate the potential problem of multicollinearity. Since Rio paid only fully-franked dividends during our sample period, there is near perfect collinearity between the first two independent variables (the correlation is 0.999), which gives nonsensical results in the first row for Rio Tinto in Table 3. If, however, we specify a value for cash dividends relative to futures payoffs, we can then reliably estimate the value of imputation credits (conditional on that value for cash dividends). Two approaches seem logical. One is to assume that cash dividends and futures trading profits are equally valued because they are taxed at the same rate and because this receives strong support in our analysis of the full sample in Table 2. An alternative approach is to assume that Rio Tinto would have a similar clientele to BHP (the other mining company in our sample). Both approaches suggest that we should impose $\beta_1 =1$. If we impose this restriction, the results suggest that the value of imputation credits is insignificantly different from zero before and after the introduction of the 45-day rule since β_2, β_3, and $\beta_2+\beta_3$ all fail to reach significance. This is perfectly consistent with the corresponding results for BHP.

The problem of multicollinearity also arises for NAB, which has never paid an unfranked dividend. The correlation between the cash dividends and imputation credits in our sample is 0.9945, which renders separate interpretation of the β_1 and β_2 coefficients impossible. For this reason, we focus on the restricted regression, as we did for Rio Tinto above.

The coefficient on the imputation credits (β_2) suggests that these credits were valued at 9-10 cents per dollar prior to the 45-day rule and that this value decreased significantly when the 45-day rule was imposed. Indeed the point estimate of $\beta_2+\beta_3$ is –14 cents per dollar and this is significantly different from zero at conventional levels. Our equilibrium analysis above suggests that non-resident investors are likely to be the marginal/price-setting providers of capital. If they are unable to utilize imputation credits after the 45-day rule, we would expect to find $\beta_2+\beta_3=0$, but this does not provide an explanation for a significant *negative* value for post 45-day rule imputation credits.

The reason for this apparently anomalous finding is that NAB paid a dividend franked to 79% in December 1999. The 26 previous dividends and the four subsequent dividends have all been fully franked. The result is that the imputation credit attaching to this dividend is lower than expected, and this causes an upward bias in the magnitude of our estimate of β_3. This is a standard errors-in-variables problem in which the *measured* regressor (the *actual* franking amount) is lower than the *modeled* regressor (the *expected* franking amount) resulting in an upward bias of the estimated coefficient. Indeed a diagnostic analysis reveals that 17 of the 20 most influential observations in our unrestricted regression relate to the December 1999 dividend. To eliminate this potential bias, we re-estimate the models, removing all observations that relate to this dividend. These results are also reported in Table 3. Eliminating the 122 observations (less than 6% of the sample) relating to this dividend results in a sharp reduction in the estimate of β_3. Moreover, the estimate of $\beta_2+\beta_3$ is essentially zero in absolute magnitude and is statistically insignificantly different from zero, which is perfectly consistent with the notion that non-resident investors who are unable to utilize imputation credits after the 45-day rule are the price-setting investors. That is, although NAB imputation credits may have had a significant, but economically small, value before the 45-day rule, there is no evidence of them having any value to the marginal investor afterwards.

Since there are a relatively small number of observations for ANZ, we draw no strong conclusions other than that the results are broadly similar to those for the other bank in our sample, NAB. In particular, the estimate of β_1 is insignificantly different from one in both the unrestricted regression and the sample that contains only unfranked dividends. This suggests that cash dividends are fully valued relative to futures payoffs, consistent with all of the evidence for the other firms in Table 3. The estimates of β_2, β_3, and $\beta_2+\beta_3$ are all insignificantly different from zero, although this is primarily driven by high standard errors and small sample sizes. Nevertheless, the results for ANZ are consistent with those for NAB, and there is nothing inconsistent with the notion that non-resident investors who are unable to utilize imputation credits after the 45-day rule are the price-setting investors.

We conclude from this analysis that cash dividends are fully valued relative to futures payoffs for our sample of firms. Also, for the four firms that we examine, we cannot reject the hypothesis that imputation credits are worthless to the marginal investor after the introduction of the 45-day rule. For the two banks in our sample, the results suggest that imputation may have been of some value to the marginal investor prior to the 45-day rule, but the rule has effectively eliminated this value. For the two mining companies in our sample, the results suggest that imputation credits were worthless to the marginal investor even prior to the 45-day rule. The key difference between these two sets of firms is that the banks have a much larger annual dividend yield of around 6% p.a., compared with 2.8% p.a. for the mining companies. If non-resident stockholders are to receive any value at all from imputation credits, they must effectively transfer ownership of the stock to resident investors around ex-dividend dates. If the supply of residents willing to take the other side of this transfer is constrained, or if transfer is costly, we would expect to see these transfers conducted for higher-yielding firms first. Also, transactions costs may render this strategy uneconomical for all but the highest-yielding stocks.

Finally, recall from Section 5.2 that our equilibrium analysis suggests that if prices are ultimately set by foreign or tax-exempt investors, we would see many observations in Areas A and B in Figure 2, and we would expect our estimates of ϕ ($\phi=\beta_2$ before the 45-day rule and $\phi=\beta_2+\beta_3$ after) in Table 3 to be significantly less than one, commensurate with the value that foreign investors place on imputation credits. Conversely, if prices are ultimately set by tax-paying domestic investors, we would see many observations in Areas A and C, and we would expect our estimates of ϕ in Table 3 to be close to one, commensurate with the value that tax-paying domestic investors place on imputation credits. For all of the companies in our sample, the results in Table 3 are consistent with the former explanation. For this reason, we interpret our results as suggesting that after the 45-day rule one dollar of imputation tax credits is worthless in the hands of a (marginal) foreign investor.

6. Conclusions

Before drawing any conclusions, recall that we have produced empirical estimates of ϕ, which represents the value of a dollar of imputation credits *actually paid* to the marginal investor. This differs from γ, which represents the value of a dollar of imputation credits *available to be paid* out. The two will only be equal if the company actually pays out all of its available imputation credits. If not, then $0<\gamma<\phi$ due to the loss of time value.

The estimation of γ is an important component of any cost of capital calculation within a dividend imputation system. Prior empirical research in this area is scarce and suffers from a range of limitations including (i) short time periods for studies, (ii) lack of data, (iii) wide confidence intervals for estimates, (iv) methodological constraints and econometric problems, and (v) anomalous results. This paper addresses some of the limitations of prior work and provides a framework for empirical estimation of the value of imputation tax credits.

Because different firms have different stockholder bases, an analysis of the "average" firm is of limited use. Our econometric methodology has the advantage that it allows us to examine a number of individual firms. Four of the largest Australian companies have sufficient data to allow individual estimation. For these four firms, we find that cash dividends are fully valued relative to futures payoffs and imputation credits are worthless to the marginal investor in ISF's and LEPO's, at least since the introduction of the 45-day rule. This is consistent with the fact that these four firms all have a large proportion of non-resident stockholders who, since the introduction of the 45-day rule, are unable to utilize imputation credits. If this 45-day rule has succeeded in eliminating the transfer of imputation credits, then non-resident investors receive no benefit at all from the dividend imputation system, whereas resident investors will benefit via lower personal tax payments. In particular, two of our sample companies were willing to supply details of the composition of their stockholder base when contacted. Around one third of BHP shares are owned by non-residents, with 14% of the stock owned by U.S. investors. Around 20% of NAB shares are owned by non-residents with 8% of the stock owned by U.S. investors. For NAB, 30% of the stock is held by domestic retail investors and 48% is held by domestic institutions.

If a company is financed solely by resident investors, the dividend imputation system will reduce its cost of capital. This is because investors will receive three components of return: capital gains, cash dividends, and imputation credits. In a classical tax system, the firm must provide a fair return to stockholders by way of dividends and capital gains only. If the imputation credits are of value to investors, the government is effectively paying part of their required return. Thus the proportion of the investors' return that must be paid by the firm (which enters the WACC calculation) will decrease.

As Officer (1988) points out, however, Australia is a small open economy so the cost of capital for Australian companies will be determined by supply and demand conditions in world capital markets. That is, large companies are unlikely to be financed solely by resident investors — at least some non-resident investment is likely to be required. Also, participants in world capital markets are free to invest anywhere, so they will only invest in a small open economy such as Australia if they receive a return that is "fair" by world standards. If imputation credits are worthless to these investors, they will only invest if they are provided with a sufficient return by way of cash dividends and capital gains.

In this case, resident investors will receive capital gains, cash dividends, and imputation credits and non-resident investors will receive capital gains and cash dividends only. Since resident investors receive a higher return (via the imputation credits granted by the local tax system), they will be the first to invest. The marginal investor will then be a non-resident, who will receive a return in the form of capital gains and cash dividends that just meets their required return. This means that 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. Our results suggest that this is the case, at least for large firms and since the introduction of the 45-day rule.

Further research into the value of imputation tax credits is of great practical importance in reliably estimating a firm's cost of capital. Of particular importance is the need to estimate the value of these credits for individual companies. As the market for ISF's, LEPO's, and other derivative products becomes more liquid for more companies it will become possible to estimate the value of imputation credits for more individual companies using the framework developed in this paper.

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Appendix: The Mechanics of the Australian Dividend Imputation System

Since 1 July 1987, Australia has operated a full imputation tax system such that stockholders can potentially receive credit for all of the tax paid at the corporate level. In this case, corporate tax (on profits that are distributed) becomes a pre-collection of personal tax.

The dividend imputation system applies to dividends paid by Australian companies that are distributed from corporate profits on which Australian corporate tax has been paid at the statutory corporate rate. Dividends carrying tax credits are termed "franked" dividends. An amount equal to the imputation tax credits attached to franked dividends is included in the assessable income of resident individual shareholders, who are then entitled to a rebate of tax equal to the amount of the imputation credit. The dividend plus the tax credit is referred to as the "grossed-up" dividend.

For a one dollar fully-franked dividend, the imputation tax credit is calculated as $\$\tau_c/(1-\tau_c)$, where τ_c is the statutory corporate tax rate. The grossed-up dividend is equal to the cash dividend plus the tax credit: $\$1 + \$(\tau_c/(1-\tau_c))$. It is this amount that stockholders who are resident natural persons or resident superannuation (pension) funds include in their taxable income. During our sample period, excess credits could be set off against tax on other income, although where the credit exceeds other tax payable it could not be carried forward or back. In addition, surplus franking credits are not refundable in cash and are therefore wasted if unable to be utilized in the tax year in which the dividend is received. Table A.1 provides an illustration of the mechanics of the imputation tax system and contrasts this with a classical tax system. This table demonstrates that under a dividend imputation system the \$100 available to the stockholder (operating income less interest) is ultimately taxed at the stockholder's personal tax rate of 47%. The \$36 of tax collected at the corporate level is effectively a pre-collection of personal tax. Under a classical tax system, dividends are taxed twice. The \$100 available to the stockholder is first taxed at the 36% corporate tax rate and the remainder is taxed at the 47% personal tax rate. After all taxes, only \$34 of the original \$100 remains, in which case the effective tax rate is 66%.

[TABLE A.1 ABOUT HERE]

Australian tax laws require that a dividend should be franked to the full extent possible. In circumstances where it is not possible to fully frank the current dividend it should be partially franked. The simplified example in Table A.2 assumes a 100% payout ratio and that the only franking credits available to the firm are those earned in the period in question. Since income derived from outside Australia does not generate franking credits (because it is subject to foreign rather than Australian corporate tax), the partially-franked dividend can be interpreted as having two components: an unfranked portion (25% of the total) and a fully-franked portion (75% of the total). The net result is a dividend franked to 75%. Table A.2 demonstrates that the foreign income is subject to double taxation (at the corporate and personal levels) but that domestic income is effectively taxed only at the personal rate.

[TABLE A.2 ABOUT HERE]

There is also a requirement that the same level of franking must apply to all shares of the same class. Anti-streaming provisions exist to prevent companies from selectively channeling their franking credits to the stockholders who value them most. Companies paying small (or no) dividends that have a surplus of franking credits are able to store them in their franking accounts.

Non-resident investors who receive franked dividends are exempt from Australian withholding taxes, but are otherwise unable to utilize the full value of the tax credit. This can be viewed as a timing advantage only, since non-resident investors will be taxed in their home country on both franked and unfranked dividends. Table A.3 provides an illustration.

[TABLE A.3 ABOUT HERE]

Table 1
Active Traders in the Feasible Equilibrium Region

The table lists the types of traders that are active in trading futures contracts in the various areas of the feasible equilibrium region in Figure 2.

Area	**Futures Buyers**	**Futures Sellers**
A	Domestic Foreign	Domestic Foreign
B	Foreign	Domestic Foreign
C	Domestic Foreign	Domestic
D	Domestic Foreign	
E		Domestic Foreign
F	Foreign	Domestic

Table 2
The Value of Cash Dividends and Imputation Tax Credits: OLS Estimates

The table contains estimates of the coefficients from the OLS regression model in Equation (4a) for unfranked dividends only:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \varepsilon_{ij}(t) \cdot$$

and Equation (4) for all dividends:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \beta_2 \frac{IC_{ij}(s)}{S_{ij}(t)} + \beta_3 DUM(t) \frac{IC_{ij}(s)}{S_{ij}(t)} + \varepsilon_{ij}(t) \cdot$$

β_o measures the average transaction cost differential. β_1 measures the value of one dollar of cash dividends relative to futures payoffs. β_2 measures the value of one dollar of imputation tax credits before the introduction of the 45-day holding period rule. β_3 measures the change in the value of one dollar of imputation tax credits after the introduction of the 45-day holding period rule. $\beta_2 + \beta_3$ measures the value of one dollar of imputation tax credits after the introduction of the holding period rule. The data were obtained from the prices of Individual Share Futures Contracts traded on the Sydney Futures Exchange over the period May 1994 - December 1999 and prices of Low Exercise Price Options traded on the Australian Stock Exchange over the period April 1995 - December 1999.

Coefficient	**All Dividends**		**Unfranked Dividends Only**
	Unconstrained	Constrained	
β_0 (std. err.)	-0.0001 (0.0002)	-0.0001 (0.0002)	-0.0001 (0.0002)
β_1 (std. err.)	0.9620 (0.0246)	0.9836 (0.0283)	0.9836 (0.0283)
β_2 (std. err.)	0.1021 (0.0549)	-	
β_3 (std. err.)	-0.2294* (0.0655)	-	
$\beta_2 + \beta_3$ (F,p)	-0.1273 (14.920, 0.061)	-	
F	1,533.51*	4,584.15*	1,204.20*
$\overline{R}^2$	0.233	0.233	0.090
N	15,111	15,111	12,099

* = significant at the 1% level. Significance for β_1 is tested against one.

Table 3

Regression Results for Individual Companies

The table contains estimates obtained from the regression model:

$$RPE_{ij}(t) = \beta_0 + \beta_1 \frac{D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)} + \beta_2 \frac{IC_{ij}(s)}{S_{ij}(t)} + \beta_3\, DUM(t) \frac{IC_{ij}(s)}{S_{ij}(t)} + \varepsilon_{ij}(t)$$

β_o measures the average transaction cost differential. β_1 measures the value of one dollar of cash dividends relative to the value of one dollar of futures trading profit. β_2 measures the value of one dollar of imputation tax credits before the introduction of the 45-day holding period rule. β_3 measures the change in the value of one dollar of imputation tax credits after the introduction of the 45-day holding rule. $\beta_2 + \beta_3$ measures the value of one dollar of imputation tax credits after the introduction of the holding period rule. Estimates for β_2, β_3, and $\beta_2 + \beta_3$ are also obtained after imposing the value of one dollar of cash dividends on the regression model due to potential multicollinearity problems. Cash dividend values of 100% and 85% (the average value in Table 2) are used. The data were obtained from the prices of Individual Share Futures Contracts traded on the Sydney Futures Exchange over the period May 1994 - December 1999 and prices of Low Exercise Price Options traded on the Australian Stock Exchange over the period April 1995 - December 1999.

FIRM	CASH DIVIDEND VALUE	β_0 (std.err)	β_1 (std.err)	β_2 (std.err)	β_3 (std.err)	$\beta_2+\beta_3$ (F,p-val)	*F* (p-val)	R^2	*N*
BHP	Unrestricted	-0.0002 (0.0002)	1.0659 (0.0456)	-0.0677 (0.0928)	-0.0731 (0.0833)	-0.1408 (0.000,1.000)	761.95 (0.000)	0.265	6,333
	100%	-0.0002 (0.0002)	1	0.0464 (0.0488)	-0.0752 (0.0833)	-0.0288 (0.000,1.000)	0.57 (0.566)	0.265	6,333
	Unfranked	-0.0002 (0.0002)	1.0702 (0.0492)				473.95 (0.000)	0.084	5,151
RIO	Unrestricted	0.0003 (0.0004)	2.2390 (2.0747)	-2.1512 (3.7439)	-0.2575 (0.1726)	-1.8937 (0.000,1.000)	247.95 (0.000)	0.704	318
	100%	0.0003 (0.0003)	1	0.0841 (0.0713)	-0.2841 (0.1666)	-0.2000 (0.000,1.000)	1.69 (0.185)	0.700	318
NAB (All Obs)	Unrestricted	0.0006 [a] (0.0002)	0.7107 [a] (0.0760)	0.6270 [a] (0.1412)	-0.2149 [a] (0.0433)	0.4121 (56.258, 0.017)	5,023.85 (0.000)	0.878	2,094
	100%	0.0006 [a] (0.0002)	1	0.0929 [a] (0.0161)	-0.2342 [a] (0.0432)	-0.1412 (57.291, 0.017)	15.26 (0.000)	0.878	2,094
NAB (Ex 12/99 Dividend)	Unrestricted	0.0007 [a] (0.0002)	0.8685 (0.0831)	0.3325 [b] (0.1543)	-0.0935 (0.0509)	0.2391 (28.129, 0.034)	4,813.42 (0.000)	0.880	1,972
	100%	0.0007 [a] (0.0002)	1	0.0896 [a] (0.0164)	-0.0860 (0.0499)	0.0035 (13.912, 0.067)	15.27 (0.000)	0.880	1,972
ANZ	Unrestricted	0.0028 (0.0025)	0.7110 (0.2804)	0.3859 (0.7010)	-0.3549 (0.6275)	0.031 (0.491, 0.484)	9.77 (0.000)	0.052	477
	100%	0.0020 (0.0024)	1	-0.1917 (0.4210)	-0.3695 (0.6274)	-0.5612 (0.978, 0.506)	0.59 (0.556)	0.056	477
	Unfranked	0.0026 (0.0030)	0.7337 (0.4644)				2.50 (0.115)	0.005	329

[a] = significant at the 1% level. [b] = significant at the 5% level. Significance for β_1 is tested against one.

Table 4
Summary Statistics for Individual Companies

This table provides summary statistics for observations that are used to estimate the parameters in Table 3. Time is expressed in years. Time to Maturity means the time between the date of the trade observation and the maturity date of an Individual Share Futures Contract (ISF) or Low Exercise Price Option (LEPO) written on the stock of the company. Time to dividend means the time between the date of the trade observation and the ex-dividend date of the company, measured in years. The period covered is from May 1994 - December 1999.

Company	BHP	RIO	NAB	ANZ
Time to Maturity				
Mean	0.2428	0.2189	0.2614	0.2864
Standard Deviation	0.1006	0.1039	0.1388	0.1533
Minimum	0.0356	0.0055	0.0603	0.0767
Maximum	0.9041	0.6904	0.8137	0.8685
Time to Dividend				
Mean	0.0978	0.1430	0.1183	0.1128
Standard Deviation	0.0866	0.0902	0.1191	0.0988
Minimum	0.0000	0.0027	0.0000	0.0027
Maximum	0.5205	0.3726	0.5945	0.4438
Number of Observations				
Total	1537	123	787	163
Fully-Franked	1182	123	498	50
Unfranked	355	0	242	15
Partially Franked	0	0	47	98
Mean Dividend Yield	0.0141	0.0144	0.0305	0.0285

Table A.1
The Mechanics of the Australian Dividend Imputation Tax System

CASH FLOW	IMPUTATION SYSTEM		CLASSICAL SYSTEM	
	GENERAL EXPRESSION	NUMERICAL EXAMPLE	GENERAL EXPRESSION	NUMERICAL EXAMPLE
COMPANY LEVEL				
Operating Income	X_O	120	X_O	120
Less Interest Payment	X_D	(20)	X_D	(20)
Taxable Income	X_O-X_D	100	X_O-X_D	100
Less Company Tax	$(X_O-X_D)(\tau_c)$	(36)	$(X_O-X_D)(\tau_c)$	(36)
After-Tax Cash Flow	$(X_O-X_D)(1-\tau_c)$	64	$(X_O-X_D)(1-\tau_c)$	64
Cash Dividend	$(X_O-X_D)(1-\tau_c)$	64	$(X_O-X_D)(1-\tau_c)$	64
STOCKHOLDER LEVEL				
Cash Dividend	$(X_O-X_D)(1-\tau_c)$	64	$(X_O-X_D)(1-\tau_c)$	64
Imputation Tax Credit	$[(X_O-X_D)(1-\tau_c)] \times [\tau_c/(1-\tau_c)]$	36	--	0
Assessable Income	X_O-X_D	100	$(X_O-X_D)(1-\tau_c)$	64
Personal Tax Liability	$(X_O-X_D)(\tau_p)$	(47)	$(X_O-X_D)(1-\tau_c)(\tau_p)$	(30)
Tax Credit Offset	$(X_O-X_D)(\tau_c)$	36	--	0
Net Tax Payment	$(X_O-X_D)(\tau_p-\tau_c)$	(11)	$(X_O-X_D)(1-\tau_c)(\tau_p)$	(30)
After-Tax Cash Flow	$(X_O-X_D)(1-\tau_p)$	53	$(X_O-X_D)(1-\tau_c)(1-\tau_p)$	34

X_O is the operating income of the company, X_D is the component of that operating income that is distributed to debtholders, τ_c is the statutory corporate tax rate (36%), and τ_p is the marginal personal tax rate (47%). The table assumes that all of the operating income after interest and taxes is distributed as a dividend.

Table A.2
Franking Level Illustration

CASH FLOW	PARTIALLY FRANKED	FULLY FRANKED
COMPANY LEVEL		
Foreign Sourced Income	20	0
Less Foreign Corporate Tax	(4)	0
Net Foreign Income	16	0
Australian Sourced Income	75	100
Less Australian Corporate Tax	(27)	(36)
Net Australian Income	48	64
Total Net Income	64	64
Cash Dividend	64	64
Franking Credit	27	36
Percentage Franked	75	100
STOCKHOLDER LEVEL		
Cash Dividend	64	64
Gross-up	27	36
Assessable Income	91	100
Personal Tax Liability	(43)	(47)
Franking Rebate	27	36
Net Payment	(16)	(11)
After Tax Position	48	53

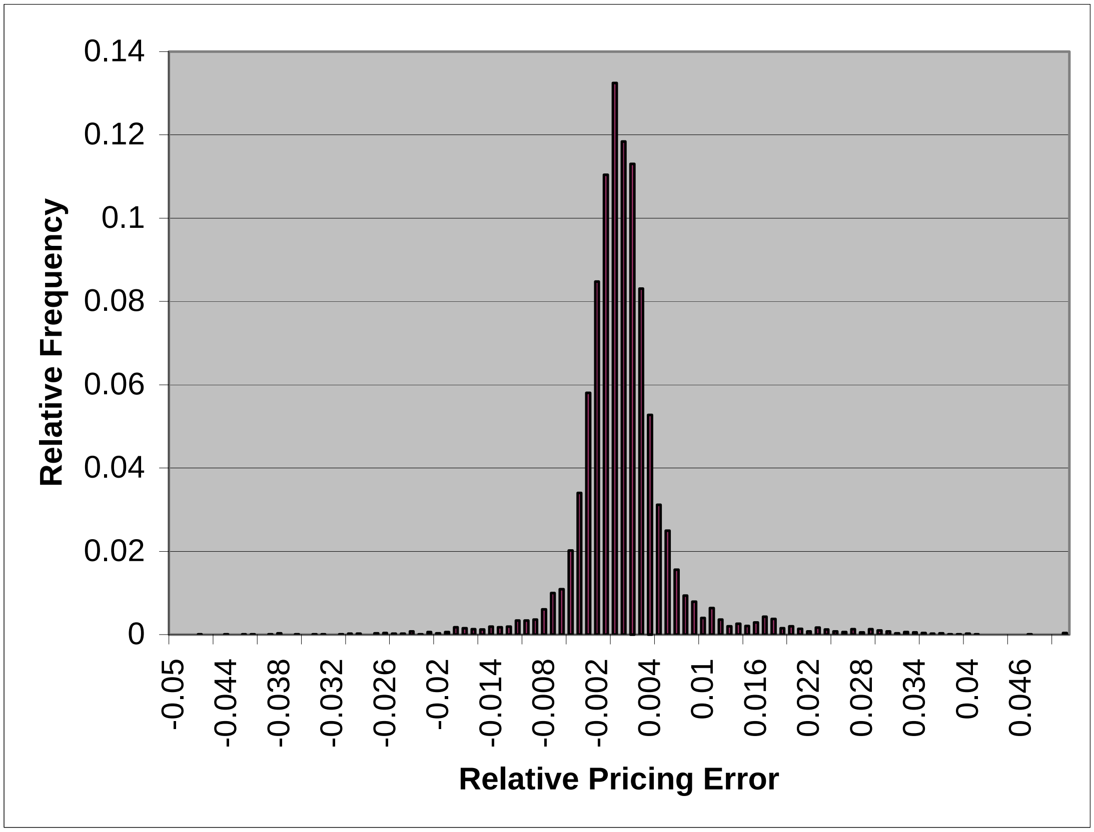
The table assumes that the foreign corporate tax rate is 25%, the domestic corporate tax rate is 36%, and the personal tax rate is 47%. In both columns, total net income is $64.

Table A.3
The Effect of Dividend Imputation on Non-Resident Stockholders

	UNFRANKED DIVIDEND		FULLY FRANKED DIVIDEND	
	U.S. Individual	U.S. Pension Fund	U.S. Individual	U.S. Pension Fund
Dividend Income	100	100	100	100
Withholding Tax	(15)	(15)	(0)	(0)
Income net of Australian Tax	85	85	100	100
Total Tax Payable - Dividend Income	(40)	(20)	(40)	(20)
Credit for Withholding Tax	15	15	0	0
Net U.S. Tax Payable	(25)	(5)	(40)	(20)
Income net of all Taxes	60	80	60	80

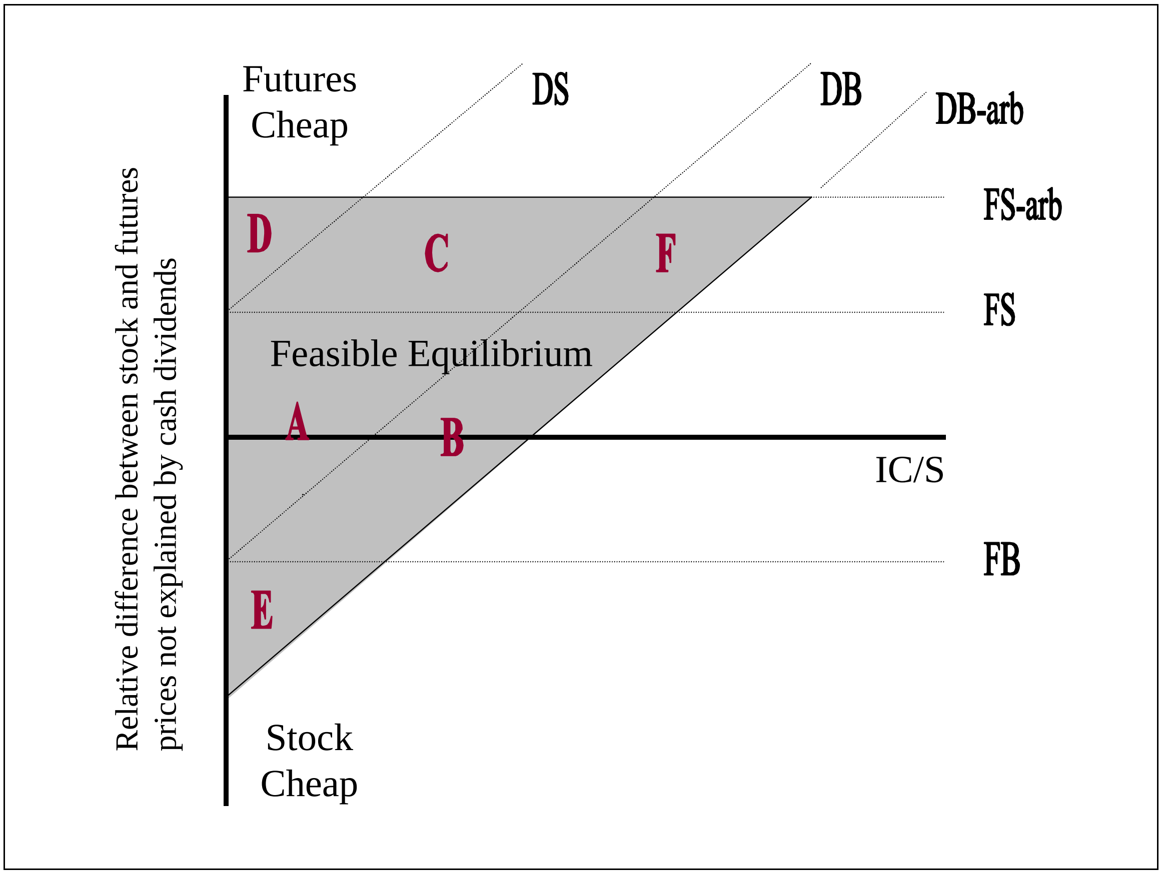
The table demonstrates the effect of the Australian dividend imputation tax system on U.S. individuals and pension funds that hold Australian stocks. The table assumes a withholding tax of 15%, and personal tax rate rates of 40% and 20% on individuals and pension funds respectively. The effect of the fully-franked dividend is one of timing only. Although the fully-franked dividend is not subject to withholding tax, the US investor is given credit by US tax authorities for the tax already levied in Australia. After all taxes have been levied the net position is the same for either form of income. The investor who has paid withholding tax has simply pre-paid some of their personal tax.

Figure 1
Distribution of Relative Pricing Error
for Individual Share Futures Contracts and Low Exercise Price Options



Pricing Error is the difference between the actual derivative security's price and its fair value (in Equation 1): $\varepsilon_{ij}(t) = S_{ij}(t)e^{r(T-t)} - F_{ij} - X$. Relative Pricing Error measures that Pricing Error as a proportion of the underlying stock's price. This histogram is based on ISF's and LEPO's that traded between 1994 and 1999, a total of 10,012 observations.

Figure 2
Feasible Equilibria



This figure shows lines of indifference between trading in stock and trading in futures for various classes of investor. FB represents indifference for foreign buyers, FS for foreign sellers, DB for domestic buyers, DS for domestic sellers. DB-arb is a line below which domestic investors can execute an arbitrage by buying stock and selling futures. FS-arb is a line above which foreign investors can execute an arbitrage by selling stock and buying futures. The shaded region represents the feasible equilibria. The horizontal axis is the imputation credit yield, $\frac{IC_{ij}(s)}{S_{ij}(t)}$ and the vertical axis is the relative difference between stock and futures prices that is not explained by cash dividends, $\frac{S_{ij}(t)e^{r(T-t)} - F_{ij}(t,T) - X - D_{ij}(s)e^{r(T-s)}}{S_{ij}(t)}$.