REVIEW OF THE ACT'S GAMMA DECISION

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EXECUTIVE SUMMARY

The Australian Competition Tribunal has recently released a decision on a number of matters including the appropriate method for estimating gamma. In response, the QCA has sought my views on the gamma aspects of the decision. My principal conclusions are as follows.

Firstly, in respect of the Officer model, rigorous proofs of the model reveal that theta is a weighted average over the utilization rates for imputation credits by individual investors and these utilization rates are 1 if investors can fully use the credits to reduce their tax obligations and zero if they cannot use them. So, theta is not the market value of the credits. Transactions and administrative costs incurred by investors in dealing with these credits cannot be dealt with by reducing the estimate for theta and, if considered important (which I do not think to be the case) would have to be addressed through an extension to the Officer model. Furthermore, this extension would only matter to the extent that the firm's equity beta differed from 1. Otherwise, such costs that are reflected in the empirical estimate for the MRP that is used by the regulator would deal with this issue. In addition, the definition of theta as a weighted average over utilization rates is consistent with the way in which company taxes are treated in tax regimes without imputation.

Secondly, and in respect of estimating theta, since the CAPM that is being used (the Officer version) assumes complete segmentation of national equity markets and this implies that all investors could use the credits, the natural choice for theta is 1 despite the empirical fact that many investors in Australian equities are foreigners who cannot use the credits. Furthermore, given that national equity markets are partly integrated, estimating theta at 1 seems to be the only approach that leads to estimates of the cost of equity that will typically lie within the range arising under complete segmentation and complete integration of national equity markets.

Thirdly, if this approach to estimating theta is not adopted and foreign investors are recognized when estimating theta, they ought to be also recognized in defining theta and therefore the natural estimate for theta is the proportion of Australian equities held by local investors. With this approach, I favour the use of all equity rather than only listed equity and therefore an estimate for theta of at least 60%. This conclusion is strengthened by the existence of any (successful) tax-trading around ex days, which would raise theta above the

proportion of Australian equities held by local investors, whilst consideration of terms other than market weights in the formula for theta would have the opposite effect. The net effect of these two forces is unclear. So, any estimate of theta of this type is subject to errors in either direction and therefore is *not* an upper bound on an estimate of theta.

Fourthly, and again conditional upon recognizing the existence of foreign investors, my next preferred method for estimating theta is the redemption rate for imputation credits. If correctly measured, this rate would overestimate theta because local investors would tilt towards stocks with high imputation credit yields and because of terms other than market weights in the formula for theta. Furthermore, the ATO data from which the redemption rate is estimated contains significant unexplained discrepancies, which give rise to two significantly different estimates of the redemption rate. Accordingly, any estimate of theta of this type is very unreliable, and therefore inferior to the proportion of Australian equities held by local investors.

Fifthly, and again conditional upon recognizing the existence of foreign investors, my least preferred method for estimating theta is the use of market prices to estimate the value of the credits. The conditions under which the use of market prices would generate an unbiased estimate of theta are very unrealistic and therefore it is highly likely that the estimates are biased (but of unknown direction). In addition, such estimates are highly variable according to the type of market data that is used (with dividend drop-off studies being merely one such type), the choice of statistical model, the criteria for selecting data, and the treatment of outliers in the data. On both counts, these estimates of theta are highly undesirable and likely to be even worse than the redemption rate.

Sixthly, and in respect of the distribution rate, since it is a firm-specific parameter whilst theta is a market parameter, theta must be estimated using market-wide data whilst the distribution rate could be estimated using firm, industry, or market-wide data according to which was judged to provide the best estimate for this firm-specific parameter. So, consistency is *not* essential. Furthermore, pragmatic considerations point to the use of market-wide data of some sort. Since the distribution rates for listed and unlisted businesses are significantly different and (private) regulated businesses are listed or owned by listed parents, the distribution rate for regulated businesses should be estimated from that of listed equity. The choices here are ATO data on all listed equity or financial statement data on a subset of high value firms constituting a majority of the value of listed equity. Since the ATO data contains significant unresolved discrepancies, this favours the use of financial statements for a subset of high value firms and an estimate of this type is 0.83 for the top 20 such firms. Many of these firms have significant foreign operations, which are irrelevant to an estimate of the distribution rate for regulated businesses. The effect of this feature of these firms is to underestimate rather than overestimate the distribution rate for the benchmark firm. Thus, the appropriate estimate for the distribution rate for the benchmark firm is at least 0.83.

Seventhly, and in relation to the ACT's views on theta, the ACT (consistent with the view of the Network Applicants) believes that theta is the market value of the imputation credits, and is therefore best estimated by studies using market data. However, this view that theta is the market value of the credits is not supported by any statement in the Officer paper nor by any rigorous derivation of the model. On the contrary, rigorous derivations show that theta is a complex weighted average over the utilization rates for credits by investors, with the utilization rate being the eligibility to use the credits. Thus, estimates of the market value of the credits are not the natural method for estimating theta. Instead their usefulness along with that of alternative methods for estimating theta must be assessed by how well they compare with the definition of theta. As discussed above, estimates of the market value of the credits are biased and highly variable estimators, and are inferior to all other estimation methods that have been discussed.

In addition, and in respect of the ACT's apparent belief that theta is a market value because the costs of debt and equity are market values, there is no inconsistency within the Officer model arising from theta not being a market value whilst the costs of debt and equity are. The model comprises some parameters that are market values (such as the cost of equity) and others that are not (such as the corporate tax liabilities and theta).

Furthermore, and in respect of the ACT's view that the best estimate of theta is 0.35 from SFG's dividend drop-off study, it is understandable in view of the ACT's view that theta is the market value of the credits that it prefers market studies to other types of evidence. However, the ACT fails to explain why they prefer a dividend drop-off study to any of the other three market study methodologies that have been used, nor do they explain why they prefer the SFG study to a more recent dividend drop-off study by other authors, nor do they explain why they prefer “robust regression” with the default value for the tuning coefficient, nor do they explain why they prefer SFG’s method for deleting outliers over the alternative method in this other paper. In addition, the ACT fails to explain their acceptance of results from a methodology that is highly sensitive to a number of irrelevant factors such as the degree of tax arbitrage, anomalous behavior around ex-days, and bouncing between the bid and ask prices.

Furthermore, and in relation to the ACT’s view that the redemption rate and the estimate from the equity ownership approach are upper bounds on the estimate of theta, due to time delays, administrative costs in distributing the credits, portfolio effects, and the effect of the 45 day rule, this might seem to follow from their view that theta is the market value of the credits. However, theta is not the market value of the credits, and this alone undercuts this reasoning. In addition, even if theta were the market value of the credits, the belief that the equity ownership proportion is necessarily above the market value of the credits due to administrative costs, time delays, portfolio effects, etc is wrong. For example, if 50% of Australian equities were foreign owned, tax arbitrage involving local investors buying shares shortly before dividend ex-days and selling them shortly afterwards could lead to all credits being redeemed by locals and therefore the market value on the credits could be above 0.50.

Lastly, and in relation to the ACT’s views on the distribution rate, the ACT’s preference for past practice leads to an estimate of 0.70 for all equities using ATO data, but is not supported by any reasoning from them. My own views are expressed above: the distribution rate is best estimated using data from listed companies and in particular from the financial statements of the 20 largest listed firms, leading to an estimate of at least 0.83.

1. Introduction

The Australian Competition Tribunal (ACT, 2016) has recently released a decision on a number of matters including the appropriate method for estimating gamma. In response, the QCA has sought my views on the gamma aspects of that Decision. Before seeking to provide my views, I present some background discussion on the relevant theory and empirical evidence.

2. Background

2.1 Theory

Australian regulatory practice is to invoke the Officer (1994) valuation model for determining the allowed price or revenues in a regulatory situation. In the interests of focusing upon the crucial issue, I consider the case in which the firm is all equity financed and the expected cash flows are constant. Letting *Y* denote the firm's cash flows before company tax, *TAX* the company tax payments made by the firm, R_f the risk-free rate before personal tax and other personal costs, R_m the rate of return on the market portfolio exclusive of imputation credits and also before personal tax and other personal costs, Q_m the ratio of imputation credits attached to dividends on the market portfolio to the value of that portfolio one year earlier, β the beta for this firm, *F* the distribution rate for the firm's credits, and θ a parameter whose definition and value are contentious, the value now of the firm is as follows:

$$S = \frac{E(Y) - E(TAX) + E(TAX)F\theta}{R_f + [E(R_m) - R_f + E(Q_m)\theta]\beta} \qquad (1)$$

It is uncontentious that "gamma" is the product $F\theta$. Turning now to the parameter θ ("theta"), the definition of any parameter within a model is obtained by inspection of a rigorous derivation of the model.[1] This literature commences with Officer (1994), who implicitly assumes that the distribution rate is 1 and hence gamma and θ are equivalent. Officer (1994) initially defines gamma as the "value of the personal tax credits" (ibid, page 1). This may or may not be intended to mean market value. Subsequently, he defines it as the "proportion of tax collected from the company which gives rise to the tax credit associated with a franked dividend" (ibid, page 4), which clearly is not a market value. He

[1] I will denote this parameter as theta rather than the utilization rate, because theta is a more neutral term.

then states that "gamma can be interpreted as the value of a dollar of tax credits to the shareholder" (ibid, page 4), with a footnote to this stating that

"*For example, if the shareholder can fully utilise the imputation tax credits, then gamma = 1, eg a superfund or an Australian resident personal taxpayer…Where there is a market for tax credits one could use the market price to estimate the value of gamma for the marginal investor…*"

This implies that gamma is not a market price and is instead something that can be *estimated* from market prices. Furthermore, Officer provides no formal derivation of his model and therefore it is not possible to determine unambiguously how the parameter gamma (and hence theta) is defined in his model. By contrast, papers by Monkhouse (1993) and Lally and van Zijl (2003) provide rigorous derivations of the Officer model. Unfortunately, Monkhouse (1996, footnote 20) does not disclose his entire proof. This leaves Lally and van Zijl (2003, section 3), who provide a formal derivation of a generalisation of Officer's model (with the Officer model being a special case). In this derivation, they show that θ is a complex weighted average over the "utilization" rates for imputation credits of all investors holding risky assets, where the weights (x_i) involve each investor's investment in risky assets and other terms (to be described in the next section). Letting U_i denote the utilisation rate for investor *i*

$$\theta = \sum x_i U_i \tag{2}$$

In respect of U_i, this appears within the definition of the post-tax rate of return on asset *j* for investor *i* (R_{ji}), i.e., letting P_j denote the price of the asset at the beginning of the period, ΔP the price change over the period, D_j the cash dividend during the period, IC_j the attached imputation credits, T_i the tax rate on gross dividends received by investor *i*, and T_{gi} the tax rate on capital gains received by investor *i*, then:

$$R_{ji} = \frac{\Delta P}{P_j}(1-T_{gi}) + \frac{D_j\left(1+U_i IC_j\right)}{P_j}(1-T_{pi}) \tag{3}$$

So, U_i is the augmentation to the cash dividend received by investor i per $1 of imputation credit. This reflects the *eligibility* of the investor to use the credits; $U_i = 1$ if the investor is eligible to fully use the credits and 0 if they cannot use them. So, definitionally, θ is *not* the market value per $1 of distributed credit (although the two might match under particular circumstances). Furthermore, θ cannot be directly determined because all components of the weights in (2) are not observable. So, it must be estimated, a variety of methods have been invoked, and these will be considered in the next section.

To emphasise the importance of a rigorous derivation of a model in determining the definition of a parameter, suppose a model contained a parameter Z and there were competing views about its definition because the author of the model had failed to unambiguously define Z. Furthermore, inspection of the proof for the model revealed that Z was used in substitution for $(X + Y)$ at some point in the derivation, and thereafter only Z was used. Accordingly, Z would then be $(X + Y)$ and this would remain so regardless of how many analysts thought otherwise. It would even remain true if the author of the model had mistakenly defined Z to be $(X – Y)$ but proceeded to use Z in substitution for $(X + Y)$. So, the derivation of a model settles all questions concerning the definitions of parameters in the model.

By contrast with this approach to determining theta and the conclusion that it is a weighted-average over investors' utilization rates, some papers claim that theta is the market value per $1 of distributed imputation credits; in particular, SFG (2014b, para 12), NERA (2015, page 3), and Frontier Economics (2016, pp. 7-9). Various bases for this claim are presented in these papers. The first of these is to cite clause 6.5.3 of the National Electricity Rules (AEMC, 2016), which defines gamma as the "value of imputation credits". By implication, θ must be the value per $1 of distributed credits. However, consistent with finance involving considerable recourse to mathematical formulas, the word "value" in a valuation model is capable of meaning the "numerical level" of a parameter. This has no particular market value connotations, and it would not even be true to say that "value" ordinarily means market value in this context. Even the ACT (2016, para 1010) implicitly recognizes that "value" could mean "numerical level" because it defines the distribution rate by using the word "value", by which they must mean the "numerical level" of this parameter because market value has no application here. Furthermore, the NER is not the arbiter on this matter. Nor is the ACT. The only arbiter is a rigorous derivation of the model in which the parameter appears.

Secondly, NERA (2015, Appendix A) claims to derive the Officer CAPM, as shown in their equation (A.10), with theta defined as the "value placed on a dollar of imputation credits by the representative investor". However, NERA's model recognises foreign assets as well as local assets, and therefore is an international CAPM rather than the Officer CAPM (which is a domestic CAPM). Furthermore, despite claiming that theta is the value placed on the credits, NERA's equation (A.11) in which theta is actually defined states that

$$\theta = \frac{D}{D+F}$$

where D is the wealth of investors who can use the credits (domestic investors) and F the wealth of those who cannot (foreigners). This is not the market value of the credits but simply the proportion of current wealth held by investors who can use the credits (to reduce their tax bills). NERA assume that local investors can fully utilise the credits and foreigners cannot use them. So, had they deferred such assumptions until the model had been developed, the last equation above would instead have been as follows:

$$\theta = \left(\frac{D}{D+F}\right)U_D + \left(\frac{F}{D+F}\right)U_F$$

where U_D is the utilisation rate of domestic investors and U_F that for foreigners. Under NERA's assumptions of $U_D = 1$ and $U_F = 0$, the last equation reduces to its predecessor. So, NERA's theta would be a weighted average over the utilisation rates of investors. This is not the market value of the credits and is instead similar to the definition in equation (2) above. So, far from demonstrating that theta in the Officer model is the market value of the credits, NERA's proof simply confirms the conclusion in Lally and van Zijl (2003) that it isn't.

Thirdly, SFG (2014b, Appendix 5, paras 320-327) attempts to deduce the definition of theta from some calculations performed by Officer. This approach is a poor substitute for examining a rigorous proof. Furthermore, SFG does not even carry out this exercise properly and correction of their error would reverse their conclusion. In particular, SFG (ibid, para 324) gives a valuation formula for equity in the presence of imputation credits as

$$E = \frac{X_0 - X_D - TAX + \gamma IC}{r_e}$$

where X_0 is pre-tax profit, X_D is interest, r_e is the cost of equity, γ is gamma, and IC is the credits created. This is a simplified presentation of equation (1) above. SFG (ibid, para 325) then repeat the exercise for a firm without imputation credits, to obtain the equity value in the absence of credits:

$$E_{ex} = \frac{X_0 - X_D - TAX}{r_e}$$

SFG (ibid, para 326) then takes the difference in these two equity values and solves for gamma:

$$\gamma = \frac{E - E_{ex}}{IC}$$

This says gamma is the value increment from the credits as a proportion of the credits created, and SFG (ibid, para 327) therefore concludes that gamma has a value interpretation. However, SFG has overlooked the cost of equity and the last equation should instead be

$$\gamma = \frac{(E - E_{ex})r_e}{IC}$$

This is mathematically equivalent to the following

$$E - E_{ex} = \frac{\gamma IC}{r_e} = \frac{\theta F(IC)}{r_e}$$

In plain English, this says that the value increment from the credits is the quantity of the credits created through the payment of company tax to the ATO (*IC*), multiplied by the proportion distributed (*F*), multiplied by theta, and then divided by the cost of equity. The last step (dividing by the cost of equity) is the valuation process because it allows for both of the crucial elements in valuation: the time value of money and risk. Furthermore, since the proportion of distributed credits that can be utilized by investors to reduce their tax bills is not reflected in either *F* or r_e, then it must by default be reflected in theta. So, if one were to attempt to deduce the definition of theta in the way that SFG has, such a process would lead to the conclusion that theta was some sort of average utilization rate for the credits rather than being a market value per dollar of distributed credits. However, such a process is both inadequate (because it does not reveal the exact nature of the averaging) and unnecessary; to establish the definition of a parameter in a model, one need only inspect a rigorous derivation of it, and this is available in Lally and van Zijl (2003) for the parameter theta.

Fourthly, SFG (2014b, Appendix 6) does examine the Lally and van Zijl (2003) model. SFG asserts that this model is based upon a set of assumptions, including the assumption that the Australian equity market is completely segregated from other equity markets (Australian investors cannot purchase foreign equities and foreigners cannot purchase Australian equities). This is true, but it is equally true of the Officer (1994) model. SFG recognizes that, in Lally and van Zijl's (2003) model, theta is a weighted-average over the utilization rates of individual investors, as shown in equation (2). SFG asserts that this definition will only match the market value of the credits (and therefore both market studies and the use of equation (2) could be adopted to estimate theta) if the model's assumptions are valid. Since the assumption concerning market segmentation is not, then SFG argues that equation (2) is invalid and the credits must then be valued using market studies. SFG's discomfort with the Lally and van Zijl model, on the grounds that an assumption is violated, is unobjectionable. However, the model has not been offered as an alternative to the Officer model in the present situation. It is a generalization of the Officer model, to allow for differential personal taxation of capital gains and other investment income. It's contribution here is purely to supply a rigorous derivation of the Officer model, and therefore to demonstrate that theta in Officer's model is defined as in equation (2). SFG does not like this definition, and rightly appreciates that it springs from certain assumptions. However, one cannot use the Officer model, as SFG does, but reject the definition for a parameter within that model. Models are not like cars with various choices over colour and engine size. If one uses a model, one must accept the definitions of parameters that arise in that model. Theta is one of the parameters in the Officer model and it is defined as in equation (2). Perhaps SFG believes that the Officer model can be derived in a way that involves theta being defined as the market value of the credits. If so, they should do so. However, I do not think it is conceivable that any alternative derivation of the Officer model could produce a definition for theta as the market value of the credits, and NERA's attempt to do so merely confirms this.

Having established what theta is, I now turn to certain assumptions that underlie equation (3). Firstly, if an investor is eligible to utilize imputation credits, a $1 increment to IC_j is as good as a $1 increment to D_j. Secondly, the only subtraction from the dividends received by an investor is personal tax. Thus, there are assumed to be no transactions costs, administrative costs or delays in receiving dividends or the credits. These assumptions are particularly important because these additional phenomena have been the subject of considerable debate in relation to imputation credits. One view is that these additional phenomena exist, estimates of θ derived from market prices reflect them, and this is an advantage to these estimates (see AGN, 2016, pp. 11-12). Clearly, a proponent of this view would not be invoking equation (3). Instead they might be thought to be using (3) subject to defining U_i to be the augmentation to the dividend arising from IC_j but net of any transactions costs, administrative costs, and delays in receipt associated with the credits. So, even for an investor who is eligible to fully use the credits, U_i would be less than 1. However, for an investor who is eligible to fully use the credits, the tax rate T_{pi} is levied on the sum of D_j and IC_j as shown in equation (3) and therefore U_i must be 1 for such an investor. So, if such costs were recognized, they would have to be recognized through an additional term in equation (3) rather than merely through the estimate for U_i. This additional term would flow through to the denominator of equation (1) and the resulting model would not be the Officer model. Furthermore, if these additional costs were recognized in respect of imputation credits, they would also have to be recognized in respect of cash dividends, and therefore a further term would have to be added to equation (3), with flow through to the denominator of equation (1). Again, this model would not be the Officer model. Letting C denote this additional term for the firm in question, and C_m its counterpart for the market portfolio, equation (3) would become

$$S = \frac{E(Y) - E(TAX) + E(TAX)F\theta - C}{R_f + [E(R_m) - R_f + E(Q_m)\theta - C_m]\beta} \qquad (4)$$

In addition, the value for $E(R_m)$ would be higher to reflect the existence of these costs, and this would be reflected in the empirical estimate. Failure to explicitly recognize these costs would not matter if beta were equal to 1, because the omissions net out in the denominator and numerator of equation (4), leaving only the increment in $E(R_m)$ and this would be empirically recognized. For regulatory purposes, with a beta of 1, the allowed rate of return would include the empirical estimate of $E(R_m)$ or the MRP and therefore would allow for these costs. However, with the AER's beta of 0.70, the failure to use a formula that explicitly accounted for them would imply that 30% of these costs were not compensated for. This is not a material issue because these costs are very small (as a proportion of the cash dividend or the imputation credits as appropriate) but I have explored the theoretical implications here because these costs have been the subject of so much debate in the present situation.[2]

Since theta relates to imputation credits, and imputation credits are part of the company taxes that are paid, it is useful to consider how company taxes in a non-imputation regime are treated in valuation exercises. Suppose a project will deliver cash flows of \$10m before company tax in one year, give rise to a legal obligation to pay company taxes of \$3m for certain in one year, and the risk-free rate is 5%. All conventional valuation exercises would value this project by discounting the net cash flow of \$7m by the risk-free rate of 5% to yield a value of \$6.67m as follows:

$$V = \frac{\$10m - \$3m}{1.05} = \$6.67m$$

So, in this exercise, the only relevant feature of these company taxes is the legal obligation, not their 'market value'. Suppose now that the company tax rate is reduced to zero, thereby reducing the legal obligation regarding company taxes to zero. When conventionally assessed, the value of the project would rise by \$2.86m. Suppose instead that imputation is introduced, all investors can use the credits, and all of them were distributed to investors. This distribution reduces the company taxes to zero, and therefore should also raise the value of the project by \$2.86m. Such a result is achieved when theta is defined as a utilization rate, which is 1 in this case. So, defining theta as an average over investors' utilization rates for credits (1 for fully usable and 0 if not usable) is not only consistent with the Officer model but with the treatment of taxes in a non-imputation regime.

In summary, within the Officer model, theta is a weighted average over the utilization rates for imputation credits by individual investors and these utilization rates are 1 if investors can fully use the credits and zero if they cannot use them. So, theta is not the market value of the

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[2] In respect of the administrative costs of the imputation credits, these consist of retaining the notice relating to the credits that accompanies the dividend payment and a few minutes additional time in the course of filling out a tax return. In respect of delays in receiving the credits, the amount is certain and therefore the appropriate discount rate would be the risk-free rate. At the current such rate for one year, the discount would be only 2% per year and 30% of this (the uncompensated part) would be only 0.3% per year. This is trivial.

credits. Transactions and administrative costs incurred by investors in dealing with these credits cannot be dealt with by reducing the estimate for theta and, if considered important (which I do not think to be the case) would have to be addressed through an extension to the Officer model. Furthermore, this extension would only matter to the extent that the firm's equity beta differed from 1. Otherwise, such costs that are reflected in the empirical estimate for the MRP that is used by the regulator would deal with this issue. Finally, defining theta as a weighted average over utilization rates is also consistent with the way in which company taxes are treated in tax regimes without imputation.

2.2 Estimation of Theta

Theta has been estimated in a number of different ways. The first of these involves the proportion of Australian equities held by local investors (the equity ownership approach). As shown in section 2.1, theta is a weighted average over the utilization rates for investors, equal to 1 for those who are able to fully use the credits and zero if they cannot use them. Letting w_i denote the fraction of aggregate risky assets held by investor i, R_{Ki} the rate of return after personal tax and inclusive of imputation credits on the "tangency portfolio" chosen by investor i, R_{fi} the risk-free rate received by investor i after personal tax, and T_{gi} the tax rate on capital gains faced by investor i, Lally and van Zijl (2003, equation (7)) show that the weight for investor i in equation (2) is as follows:

$$x_i = \frac{\left[\dfrac{w_i}{\left(\dfrac{E(R_{Ki}) - R_{fi}}{Var(R_{Ki})}\right)(1-T_{gi})}\right]}{\sum_{j=1}^{n}\left[\dfrac{w_j}{\left(\dfrac{E(R_{Kj}) - R_{fj}}{Var(R_{Kj})}\right)(1-T_{gj})}\right]}$$

As shown in Lally and van Zijl (2003, section 3), the Officer (1994) model is a special case of this in which the tax rates on dividends, interest and capital gains are equal for each investor. Letting T_i denote investor i's personal tax rate, R_i the before personal tax equivalent to R_{Ki}, and R_f the risk-free rate before personal tax, the last equation then reduces to

$$x_i = \frac{\left[\dfrac{w_i}{\left(\dfrac{E(R_i)(1-T_i)-R_f(1-T_i)}{Var(R_i)(1-T_i)^2}\right)(1-T_i)}\right]}{\sum_{j=1}^{n}\left[\dfrac{w_j}{\left(\dfrac{E(R_j)(1-T_j)-R_f(1-T_j)}{Var(R_j)(1-T_j)^2}\right)(1-T_j)}\right]} = \frac{\left[\dfrac{w_i}{\left(\dfrac{E(R_i)-R_f}{Var(R_i)}\right)}\right]}{\sum_{j=1}^{n}\left[\dfrac{w_j}{\left(\dfrac{E(R_j)-R_f}{Var(R_j)}\right)}\right]} \quad (8)$$

If the rate of return terms on the RHS of this formula were equal across investors, then equation (8) reduces to

$$x_i = \frac{w_i}{\sum_{j=1}^{n} w_j} = w_i \quad (9)$$

This says that the weight applied to investor *i* in equation (2) is the proportion of Australian equities held by investor *i*. Substituted into equation (2), with those investors who are eligible to use the credits designated as investor type 1 and the rest as type 2, theta becomes

$$\theta = w_1(1) + w_2(0) = w_1 \quad (10)$$

So, theta would be the proportion of Australian equities held by those investors who are able to use the credits. However the terms in the RHS of equation (8) may vary over investors, but do not readily lend themselves to estimation. Since this issue only matters if foreign investors are included, because they are the only significant group who can't use the credits, I assume at this point that they are included.[3] Accordingly, the crucial issue is whether the additional terms on the RHS of (8) differ between local and foreign investors. The only clear point of distinction between these two groups is that local investors receive imputation benefits, which are included in R_i, and foreign investors don't.

[3] If all investors can use the credits, then the utilization rate is 1 for all investors and therefore theta is also 1 regardless of the weights applied to individual investors.

To investigate the impact of this issue, I assume that there is only one Australian risky asset. In this case, the variance terms cancel out of equation (8). A recent estimate of the Australian market dividend yield is .052 (Lally, 2015c, page 32) and the contemporaneous (September 2015) ten-year risk-free rate was .027. In addition, the MRP estimate used is the QCA's current estimate of .065 (QCA, 2014, page 23). This implies an expected return on equity before imputation credits of .092, comprising an expected cash dividend yield of .052 and therefore expected capital gains of .040.[4] The imputation benefits for investors who can fully use them are the product of the cash dividend yield (.052), the maximum attachment rate (0.43), and the proportion of dividends that are fully imputed (0.75: see Brailsford et al, 2008, footnote 23), which is .017. So, for local investors (who can fully use the credits and are designated type 1 investors), the expected rate of return before personal tax on the risky asset is .109 as follows:

$$E(R_1) = (.052 + .017) + .04 = .109$$

By contrast, for foreign investors (who can't use the credits and are designated type 2 investors), the corresponding figure is $E(R_2) = .092$. For both investor types, the risk-free rate is .027. Substitution of these parameter values into equation (8) along with value weights for the two investor groups of (say) 0.50 each, yields a weight for local investors of 0.44 as follows:

$$x_1 = \frac{\left[\dfrac{0.50}{.109 - .027}\right]}{\left[\dfrac{0.50}{.109 - .027}\right] + \left[\dfrac{0.50}{.092 - .027}\right]} = 0.44$$

So, the weight from equation (8) is less than the value weight of 0.50. Using value weights of 0.60 for local investors and 0.40 for foreign investors would produce the same difference of 0.06. So, using value weights overestimates the appropriate weight for local investors in equation (8) by 0.06.

[4] The QCA's MRP estimate of .065 includes an allowance for imputation credits but it is not possible to separately identify this. The component would be small because the QCA's estimate of the utilization rate is 0.47 (QCA, 2014, page 29) and the credits exert little impact on the MRP estimate from two of the four estimation methods used by the QCA. So, I act as if this component would not change the QCA's (rounded) estimate.

I turn now to the question of which investors are recognized in equation (8). The Officer (1994) model assumes that the Australian equity market is segregated from the rest of the world, which would imply no foreign investors. Accordingly, all investors would be locals and therefore theta would be 1. However, foreign investors do exist, and therefore the assumptions of the model collide with an empirical reality. One approach to this, which I favour, would be to ignore foreign investors and therefore estimate theta as 1 because doing so would produce an estimate of the cost of equity that at least lay within the bounds arising if equity markets were completely segregated and completely integrated (Lally, 2013a, section 3.1). However, none of the parties to the dispute considered by the ACT share this view and instead all of them consider that foreign investors should be recognized. If this view were correct, and assuming that no foreign investors could use the credits whilst all local investors could, the market weight of investors who could use the credits would be the market weight of local investors, i.e., the proportion of Australian equity held by local investors.

This reasoning presumes that no foreign investors can use the credits. However, there are some contrary possibilities. The most widely commented on method is to temporarily transfer ownership of shares to local investors around dividend ex-days (tax arbitrage). If successful, despite the 45 day rule that has been adopted in order to curtail this activity, the in substance effect would be for foreign investors to be able to use the credits. I do not know what the current extent of this activity is, but it *may* not be substantial because the legislative rules that discourage such behaviour are extensive and are likely to have significantly constrained such activity.[5] However, to the extent that such activities are still (successfully) occurring and thereby raising theta, the consequence is that the equity ownership approach would tend to underestimate theta, i.e., the approach is biased down.

[5] These rules comprise the "holding period rule" (requiring investors who can utilize the credits to hold the shares for at least 45 days around the dividend ex-day as a condition for receiving the benefit from the credits), the 30% delta rule (requiring investors who can utilize the credits and hold shares around the dividend ex-day to be at least 30% exposed to movements in the stock as a condition for receiving the benefit from the credits), and the "related payments rule" (proscribing certain classes of transactions between investors who can and cannot utilize the credits), as discussed in Beggs and Skeels (2006, Appendix A). In addition to discouraging tax arbitrage, such rules may prevent some 'genuine' investors from receiving the credits. However, this effect is unlikely to be significant because 'genuine' investors have the option of changing the timing of their transactions, the timing change would not be material, and they would have strong incentives to do so.

To illustrate this, suppose that 90% of the shares of all Australian companies are held equally by resident and foreign investors throughout the course of a year (type A shares) and the other 10% are held by foreign investors except for a period of 50 days around each dividend, during which they are held by local investors for purposes of tax arbitrage (type B shares). So, the proportion of shares held by investors who can use the credits (through any method) is 50% of the type A shares plus all of the type B shares, which is 55% of all shares. However the proportion of shares held by local investors is 50% of the type A shares and 27% of the type B shares (with the latter figure representing the 100 days per year that local shareholders hold the type B shares around the two dividends per year), for a total of 47.7%. So, the equity ownership approach would underestimate theta by 7%. This may or may not offset the overestimate coming from ignoring the additional terms in equation (8).

The argument above also presumes that all Australian resident investors can use the credits, and the only apparent contrary case is 'genuine' Australian investors who are denied use of the credits under the 45 day rule (tax arbitrageurs being denied use of the credits would be an oxymoron, because they would desist from such activity if denied use of the credits). This set is likely to be very small because 'genuine' investors have the option of changing the timing of their transactions, the timing change would not be material, and they would have strong incentives to do so. Furthermore, even if the set were large, their downward impact on theta would be small because they would be holding the shares for such a small period. So, on both counts, the error in estimating theta by presuming that all resident Australian investors who hold local equities can use imputation credits would be very small.

To illustrate this, suppose that 95% of the shares of all Australian companies are held equally by local and foreign investors throughout the course of a year (type A shares) and the other 5% are held by foreign investors except for a period of 30 days around each dividend, during which they are held by local investors for reasons other than tax arbitrage (type B shares). So, the proportion of shares held by investors who can use the credits is 50% of the type A shares, which is 47.5% of all shares. However the proportion of shares held by local investors is 50% of the type A shares and 16% of the type B shares (with the latter figure representing the 60 days per year that resident shareholders hold the type B shares around the two dividends per year), for a total of 48.3%. So, the equity ownership approach would overestimate theta by less than 1%. This is inconsequential.

In estimating theta from the proportion of Australian equity held by Australian residents, estimation errors can also arise from the choice of whether to use only listed equity or all equity, and which historical time period to average results over. The AER (2015, page 4-26) presents estimates ranging from 38% to 55% if only listed equity is used, and 56% to 68% if all equity is used, with the variation within each data set representing the range of values over the 2000-2014 period (AER, 2015, Figure 4-3). The latest (2014) values of these two parameters are 47% and 61% respectively, and these values are well within the range of the recent experience. If one judged these time series to be random walks, one would estimate the future values (over the next regulatory cycle of five years) using the latest observations. Alternatively, if one judged these series to be mean reverting, the estimate would be the current observation adjusted upwards (downwards) if the current observation was unusually low (high). However, the current observations are not unusually high or low. So, even if these series are mean reverting, reasonable point estimates for the next five years would still be approximately the latest values of 47% and 61% respectively, with moderate uncertainty around these estimates. My own estimate for all equity is moderately higher, at 66% in 2013 (Lally, 2015a, page 28) versus the AER's (2015, Figure 4-3) estimate of 60% at the same point in time. So, my estimate for all equity is at least 60%.

In respect of the choice between listed and all equity, my views on this matter appear in Lally (2014, pp. 34-35). In particular, the fact that only listed equity is used to estimate the MRP and beta suggests that the same limitation be applied to the present issue. However, the limitation is only imposed for the MRP and beta because data from unlisted firms is entirely inadequate for estimating returns. Furthermore, MRP estimates are generally based on a subset of listed equity (such as the ASX200), the subsets used may vary and are sometimes never specified (in surveys), and betas are typically estimated from foreign returns data. All of these results could reasonably be viewed as proxies for the results that would arise from using Australian data on all equities. In addition, treating the CAPM as a model that applies to only listed equities would rule out using it to estimate the cost of equity for an unlisted company (and some regulated businesses are unlisted). Thus, in principle, I favour inclusion of unlisted equity for estimating the proportion of Australian equities held by local investors. Some concerns about the quality of this data seem warranted, as argued by SFG (2014a, pp. 30-33), but the results showing that the local ownership proportion of unlisted equity is higher than for listed equity (Frontier, 2016, Table 4) are entirely plausible (because foreigners would be expected to favour listed equity due to its higher liquidity).

The next possible approach to estimating theta is to use the redemption rate of imputation credits. To explore this question, let IC_1 denote the imputation credits issued to investors who can redeem them, IC_2 to those who can't, and TR the total credits redeemed over the same period. Accordingly the redemption rate is

$$R = \frac{TR}{IC_1 + IC_2}$$

Assuming that all (or virtually all) imputation credits that are issued to those investors who can use them are redeemed, it follows that

$$R = \frac{IC_1}{IC_1 + IC_2}$$

Assuming further that those investors who can use the credits choose Australian stocks with the same ratio of imputation credits to equity value (V) as do investors who can't use the credits, it follows that

$$R = \frac{V_1}{V_1 + V_2}$$

So, under these assumptions, the redemption rate is equal to the proportion of Australian equities held by investors who can use them, which in turn is an overestimate of theta as discussed earlier, due to ignoring other terms in equation (8). However, the last assumption described above is unrealistic. Investors who can use the credits are likely to tilt towards stocks with high IC/V ratios because only they can use the credits and the valuation of these credits is unlikely to fully reflect their full face value because the influence of other investors is significant. This would raise the redemption rate over the market weight of investors who can use the credits, which implies that the redemption rate overestimates theta.[6] So, the (correctly measured) redemption rate overestimates theta for two reasons.

[6] This would occur even if virtually all companies have undistributed credits (as seems to be the case: Lally, 2015b), leading to virtually all of them attaching credits at the maximum rate, because there is variation across companies in dividend yields and this will impart variation across companies in the IC/V ratios even with maximum attachment of credits in all cases.

Turning now to the reliability of estimates of the redemption rate, NERA (2015, section 4.2) estimate it at 0.45 using ATO tax data on all Australian companies from 2004-2012, and the AER (2016, page 4-138) has updated this to 0.48 using 2004-2014 data. However, using the same type of data from 2004-2011, Hathaway (2013, section 1.3) estimates this proportion at 0.62 or 0.44, with the variation arising from two possible approaches (ATO dividend data and ATO tax data) whose results should match and the divergence cannot be reconciled. This variation casts doubt on all estimates using ATO data, and this problem with the ATO data alleged by Hathaway is generally accepted (NERA, 2013a, pp. 5-6; Handley, 2014, section 6; Frontier Economics, 2016b, para 97; AGN, 2016, page 10; ACT, 2016, para 1092). So, the redemption rate has not to date been reliably estimated.

The next possible approach to estimating theta is the use of market prices to estimate the value of the credits. One such method, which the ACT favours, is dividend drop-off studies, and I therefore commence with them. To assess whether such an approach can estimate theta, suppose that there is no risk, no transactions costs or other frictions, all investors are able to fully use imputation credits for tax relief, and all investors are taxed on capital gains and dividends at the same rate T. Since all investors can fully use the credits, theta is 1. Letting D denote the cash dividend, IC the imputation credits, ΔP the price change from cum to ex-div, and P the cum-div price, arbitrage would ensure that

$$(D + IC)(1 - T) = \Delta P(1 - T)$$

and hence

$$\frac{\Delta P}{P} = \frac{D}{P} + \frac{IC}{P}$$

So, in regressing $\Delta P/P$ on D/P and IC/P, the coefficient on IC/P (which the ACT considers to be an estimator of theta) would be 1 and this would correctly estimate theta. However these conditions are very unrealistic. If it is instead recognized that capital gains and dividends are taxed differently (at rates T_g and T_d respectively for each investor), arbitrage would instead ensure that

$$(D + IC)(1 - T_d) = \Delta P(1 - T_g)$$

and hence

$$\frac{\Delta P}{P} = \frac{D}{P}\left(\frac{1-T_d}{1-T_g}\right) + \frac{IC}{P}\left(\frac{1-T_d}{1-T_g}\right)$$

So, theta would still be 1 but the coefficient on *IC/P* would not be 1, and therefore this regression coefficient would be a biased estimator of theta. Furthermore, since capital gains are taxed less onerously than dividends in Australia, the coefficient on *IC*/*P* would be biased down as an estimator of theta. This bias is readily corrected, by dividing the estimated coefficient on *IC*/*P* by that on *D*/*P*.

I now recognize that not all investors can use the credits. Once this assumption is relaxed, there will be arbitrage opportunities for trading around ex-day, which in turn are constrained by the risk involved in holding shares and transactions costs in buying and selling them. So, it is sensible to simultaneously recognize that not all investors can use the credits and that there is risk and transactions costs in buying and selling shares. In such circumstances, the coefficient on *IC*/*P* may be a significantly biased estimator of theta and the extent of bias is unknown. To illustrate this point, suppose that 50% of investors (by value) can use the credits, the other 50% can't, and all terms other than market weights on the RHS of equation (8) are the same across investors. Theta would then be 0.50 in accordance with equation (10). So, if the share price cum-dividend were \$40, *D* = \$2, *IC* = \$1, and $T_d = T_g = .30$, then the expected ex-div share price consistent with theta = 0.50 would be \$37.50. Thus, if the expected share price ex-div were determined in this fashion by the market, then a regression of *ΔP/P* on *D/P* and *IC/P* would yield an expected coefficient on the credits of 0.50, and therefore would be an unbiased estimator of theta.

However, at such an expected ex-div share price of \$37.50, investors who could use the credits would be tempted to buy cum-div at \$40 and sell at the expected ex-div price of \$37.50, thereby receiving a dividend of \$2 and imputation credits of \$1, yielding an expected pre-tax profit of \$0.50 and an expected post-tax profit of \$0.35. Their efforts in doing this would drive the expected price drop up from \$2.50 to \$3. However, such activity would be discouraged by the transactions costs and risks of holding shares around the ex-day, and these risks would be aggravated by the need to hold the shares for 45 days in order to obtain the credits. Furthermore, investors who could not use the credits would also change their behavior. Shorting the cum-div shares and buying at the ex-div price may not be feasible.

However, at the very least, with the expected price drop at any level above $2, investors who could not use the credits but who held the shares at the cum-div date and desired to hold them in the long-term would be tempted to sell cum-div and repurchase ex-div. If the expected price drop were $3, they would experience an expected capital gain of $3 and lose a dividend of $2, for a pre-tax expected profit of $1 and a post-tax expected profit of $0.70. Their efforts in doing so would narrow the expected price drop towards $2. Furthermore, investors who could not use the credits and were holding the shares at the cum-div date but were also planning to sell them would be more inclined to sell cum-div rather than ex-div if the expected price drop exceeded $2, and the effect of doing so would also narrow the expected price drop towards $2. Furthermore, investors who could not use the credits and were not holding the shares at the cum-div date but were planning to buy them would be more inclined to buy ex-div rather than cum-div if the expected price drop exceeded $2, and the effect of doing so would also narrow the expected price drop towards $2. The last two types of transactions would also be free of any incremental transactions costs and the penultimate case would also involve less risk rather than more (by selling at the known cum-div price rather than the unknown ex-div price). Accordingly, their frequency relative to the other types of transactions would rise and this too would push the expected price drop towards $2.

The net effect of all of these transactions could produce an expected price drop anywhere in the range from $2 to $3. If the expected drop were $2.80, regressing $\Delta P/P$ on D/P and IC/P would give rise to an expected coefficient on IC/P of 0.80, which would overestimate theta (of 0.50). So, the coefficient would be significantly biased up. Alternatively, if the expected drop were $2.20, regressing $\Delta P/P$ on D/P and IC/P would give rise to an expected coefficient on IC/P of 0.20, which would underestimate theta (of 0.50). So, the coefficient would be significantly biased down.

There is considerable empirical evidence on the question of tax-induced trading around dividend ex-days, starting with Kalay (1982), and it has a number of testable implications. In particular, trading volume will be higher around ex-dividend days, it will be positively related to dividend yield and it will be negatively related to transactions costs. These predictions have all been confirmed in the US by Lakonishok and Vermaelen (1986) and Michaely and Vila (1996); the latter show that volume is twice the normal level in the 11 days around ex-day for stocks in general and 17 times normal volume for stocks with high dividend yields and low transaction costs (ibid, pp. 481-485).

Further testable implications relate to abnormal returns on ex-dividend days; these abnormal returns will change if transactions costs significantly change and they will be related to the tax rates to which tax arbitragers are subject. Naranjo et al (2000) test these predictions by examining the ex-dividend day returns for US stocks with very high dividend yields and other features that facilitate tax arbitrage, they find that the returns shift from positive in the 20 years preceding the 1975 introduction of negotiated commissions to negative in the following 20 years, and they attribute this to tax arbitrage after 1975 by corporates (who face lower taxation on dividends than on capital gains). They also found that the post 1975 ex-dividend day returns are negatively related to the tax advantage of dividends over capital gains for corporates, consistent with tax arbitrage by corporates. Eades et al (1984) also find negative ex-day returns for preferred stock, which have high dividend yields. These negative ex-day returns for high dividend yield stocks are particularly interesting because they are consistent with ex-dividend day returns being driven by a subset of investors (corporate) that constitute only about 1% of the US market (Berk and DeMarzo, 2007, page 547).

In addition to bias in estimating theta from dividend drop-off studies, the results from such studies are subject to other problems. Firstly, there are a range of possible statistical models to use. SFG (2013a, Tables 2 and 3) conduct a dividend-drop off study over the period from July 2001 to October 2012, and consider eight models with estimates of the coefficient on imputation credits ranging from 0.14 to 0.38. Furthermore, none of these eight models include a constant in their regression model, the case for doing so is not clear cut, and omission of the constant could materially alter the estimate for the utilisation rate. This doubles the number of possible models and therefore is likely to widen the range in the results.

Secondly, there are problems with the reproducibility of SFG's results. In particular, despite using the same methodology and data filtering rules to data from an almost identical period (July 2001 to July 2012 versus July 2001 to October 2012), Vo et al (2013) and SFG (2013a) generate some quite dramatic differences in results. In respect of SFG's Model 1 with OLS and the market correction, SFG (2013a, Table 2) estimates the coefficient on the credits at

0.38 whilst Vo et al (2013, Table 5) estimates it almost identically at 0.37.[7] However, SFG estimates the constant at 0.82 and the standard error on the coefficient on the credits at 0.16 whilst the corresponding figures from Vo et al (2013, Table 5) are quite different at 0.66 and 0.27 respectively. In addition, in respect of SFG's Model 1 with Robust Regression and the market correction, SFG (2013a, Table 3) estimates the coefficient on the credits at 0.29 and the standard error at 0.08 whilst the corresponding figures from Vo et al (2013, Table 5) are materially different at 0.35 and 0.11 respectively. In addition, in respect of SFG's Model 4 with Robust Regression and the market correction, SFG (2013a, Table 3) estimates the standard error on the coefficient on the credits at 0.04 whilst the corresponding figure from Vo et al (2013, Table 5) is quite different at 0.08. Such variations undercut the credibility of both papers.

Thirdly, using different (but reasonable) approaches to investigating the effect of removing outliers, the effect on the parameter estimates is quite different. For example, in respect of SFG's preferred approach involving Model 4 and "robust regression", the effect on Vo et al's estimate of the franking credit coefficient from progressively removing the 30 most extreme observations (in absolute terms), and rerunning the model after each deletion, is to generate estimates of this coefficient that (largely) progressively increase from 0.32 to 0.53 (Vo et al, 2013, Table 8 and Figure 15). Importantly, these 30 observations represent less than 1% of the total set of observations. By contrast, SFG progressively remove the 20 most extreme pairs of observations (the one that exerts the most upward effect on the franking credit coefficient and the one exerting the most downward effect) and find only trivial effect on the coefficient (SFG, 2013a, Figure 4). SFG (2014b, Appendix 9) note that their sensitivity tests are based on results using the "market correction" whilst those of Vo et al (2013) are not, but SFG go on to conduct additional tests. In particular, SFG (2014b, Figure 16) apply Vo et al's (2013) method for deleting outliers to their existing work and find that the coefficient on imputation credits varies only moderately from 0.30 to 0.38 as the 20 most extreme observations are removed. However, SFG remove only the 20 most extreme observations whilst Vo et al's (2013, Figure 15) analysis removes the 30 most extreme cases and the additional 10 observations significantly expand the range in Vo et al's (2013) analysis. Furthermore, the Vo et al (2013) results described above relate to SFG's preferred model (Model 4 with robust regression) whilst SFG's (2014b, Appendix 9) analysis involves Model

[7] SFG's Model 1, with a constant, corresponds to Vo et al's Model 2, by comparison of SFG (20134a, Table 1) and Vo et al (2013, Table 3).

4 without robust regression.[8] So, at the very least, SFG have mistakenly applied their additional sensitivity tests to the wrong model, and therefore do not rebut the problems suggested by Vo et al (2013).

Fourthly, and in respect of the robust regression models used by both SFG and Vo et al, the latter authors rerun the models with various values of the “tuning constant” in the model, and obtain significantly different estimates of the coefficient on franking credits across the range of values for the tuning coefficient, for each of SFG’s four models. For example, in respect of SFG’s model 4, the estimated coefficient varies from 0.32 to 0.64 (Vo et al, 2013, Table 11 and Figure 19).[9] Again, Vo et al’s sensitivity tests do not incorporate the “market correction” and may not hold after doing so but SFG (2014b, Appendix 9) do not investigate this issue despite being aware of it and this implies that they do not contest the point.

Fifthly, all such studies must adopt rules for selecting observations, the choice is both subjective and it may materially alter the result. For example, in respect of SFG (2013a), they delete observations from companies with a market cap below 0.03% of the market index. Since observations are also (sensibly) eliminated if trades are not present on both the cum and ex-dividend dates, this company size rule has no clear incremental value. Furthermore, the choice of 0.03% is highly arbitrary; the rule tends to exclude observations that are least likely to be contaminated by tax arbitrage (the best ones), and the rule may have significantly biased SFG’s results.

Lastly, many studies have identified various anomalies at and around ex-days that cannot be attributed to any kind of tax explanation and this raises the possibility that ex-dividend day behaviour is partly driven by these anomalies. If so, any estimate of theta of this type would be biased. For example, Woolridge (1983), Grinblatt et al (1984) and Eades et al (1984) find

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[8] SFG (2014b, Appendix 9) never state that their sensitivity analysis is applied to Model 4 without robust regression but this can be deduced by comparing the results in SFG (2014b, Figure 16) with the results for Model 4 shown in SFG (2013a, Table 2: GLS) and SFG (2013a, Table 3: Robust Regression). In particular, SFG (2013a, Table 2) gives an estimated coefficient on imputation credits of 0.3044 for Model 4 whilst Table 3 gives 0.3516, and SFG (2014b, Figure 16) shows the estimated coefficient on credits of about 0.30 when no observations have been deleted. So, the sensitivity analysis in SFG (2014b, Appendix 9) has been performed on Model 4 without robust regression. Furthermore, a comparison of their results for the other three models in SFG (2013a, Table 2 and Table 3) with their sensitivity results for those models in SFG (2014b, Appendix 9, Figure 13, 14 and 15) confirms that the sensitivity analysis in the latter paper has also been performed on each model without robust regression.

[9] Table 11 is actually labelled Table 8, but should be labelled Table 11.

abnormal returns on the ex-days for share splits and stock dividends for US stocks despite these events having no tax implications. In addition, Eades et al (1984) also find that excess returns on US stocks are abnormal for several days before and after dividend ex-day as well as on ex-day. Brown and Walter (1986, Table 3) find similarly anomalous behaviour in Australia. In relation to the ex-day results for share splits, Copeland et al (2005, page 666) comment that "..there is no explanation for the abnormally positive split ex-date returns..". In relation to the abnormal returns before and after dividend ex-days, Copeland et al (2005, page 666) also comment that "No good explanation for this result has yet been proposed." In respect of markets without taxes on dividends or capital gains, many studies still find positive abnormal returns on dividend ex-days: Frank and Jagannathan (1998) for Hong Kong, Milonas and Travlos (2001) for Greece, and Al-Yahyaee (2008) for Oman. Frank and Jagannathan (1998) attribute the apparently abnormal returns to prices that bounce between the bid-ask spread.[10] Al-Yahyaee et al (2008) test this conjecture in Oman and find that the abnormal returns there disappear when midpoint prices rather than transaction prices are used (thereby supporting Frank and Jagannathan's hypothesis).

The possible presence of tax arbitrageurs and apparently anomalous behaviour at and near dividend ex days raises significant doubts about the use of dividend drop-off studies to infer conclusions about the value of dividends (and therefore imputation credits as well), and this point is well recognised in the corporate finance literature. For example, Grinblatt and Titman (2002, page 544) say that "Other evidence leads us to suspect that the observed behaviour of stock prices on ex-dividend dates may have nothing to do with taxes". In addition, after referring to studies that reveal positive abnormal ex-dividend day returns in markets without taxation of dividends, Welch (2009, page 723) states that "This evidence should caution us not to overinterpret the US cum-to-ex price drop as a pure marginal tax effect. We may not understand this drop as well as we think."

Australian researchers have reiterated the same concerns. For example, Brown and Clarke (1993) examine dividend drop-off ratios in Australia over periods following a number of changes in tax legislation that favoured dividends over capital gains, they find results that are sometimes inconsistent with tax-based explanations for the drop-off, and they conclude that "..the tax laws are not the whole of the explanation for the ex-dividend day trade-off between

[10] The transactions before ex-day tend to occur at the bid (low) price and the sales on ex-day at the ask (high) price.

dividends and capital gains." (ibid, page 36). In addition, Walker and Partington (1999) estimate the value of dividends and credits by another methodology, they find markedly higher values for dividends and imputation credits through this approach, they refer to microstructure and tax arbitrage complications in interpreting results from traditional drop-off studies, and they state that "This raises the issue of whether use of the traditional drop-off ratio may lead researchers to make erroneous inferences." (ibid, page 294). In addition, Cannavan, Finn and Gray (2004, section 3.3) also seek to estimate the value of Australian imputation credits by another methodology, they note the concerns about microstructure and tax arbitrage in interpreting results from traditional drop-off studies, and conclude that "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." Remarkably, the last author here (Professor Stephen Gray) is also the lead author on the SFG (2013a) report. Even more remarkably, in an earlier version of the SFG (2013a) paper, and in the course of noting disadvantages of the drop-off methodology, SFG (2008, para 90) state that "..the additional trading (around ex-dividend dates) may be driven by short-term investors seeking to capture the dividend and franking credit, affecting the resulting estimates." Thus even SFG have significant doubts about the ability of their own methodology to reliably estimate the tax effects that it seeks to estimate.

In addition to dividend drop-off studies, there are other methods for estimating theta from market prices. These other methods suffer from most of the same problems. Furthermore, there is wide variation in the results across these studies. I commence with studies using data from July 2000, corresponding to the last significant relevant changes to the tax regime. Cummings and Frino (2008, Table 2, Table 4) use contemporaneous prices for a share index and futures contracts over that index (Method 2), with data from 2002-2005, and estimate the coefficient on credits at 0.52 and 0.55 from two different specifications, with an average of 0.54. SFG (2013b, Table 3) use contemporaneous prices for shares and futures contracts over those shares (Method 3), with data from 2000-2013, and estimate the coefficient on credits at 0.12. NERA (2013b, section 3) regress returns on the imputation credit yield and various control variables (Method 4), using data from 2000-2012, and estimate the coefficient on the credits at -1.95 (ibid, Table 3.5). Thus, over these four studies, each of which uses market price data from the period to which the current tax regime relates, the estimates of the coefficient on the credits range from -1.95 to 0.54. These estimates are shown in the last column of Table 1.[11]

Table 1: Comparison of Market-Based Estimates of the Coefficient on Imputation Credits

	Aug 91 - May 97	May 97 – July 99	July 00 – Oct 13
Method 1: Beggs and Skeels	0.20	0.42	
Method 1: SFG (2013a)			0.35
Method 2: Cummings and Frino			0.54
Method 3: Cannavan et al	0.16	-0.06	
Method 3: SFG (2013b)			0.12
Method 4: NERA			-1.95
Method 5: Walker and Partington	0.88		

Although results using data prior to July 2000 are of much less interest as estimates of the current value of the coefficient on credits, they also reveal a wide range in results for each period in which the tax regime is fixed. In particular, I examine some studies using data within the period August 1991 to May 1997, and May 1997 to July 1999.[12] In the first period, using contemporaneous cum and ex-div prices (Method 5), Walker and Partington (1999) estimate the coefficient on credits at 0.88 (ibid, page 293). Also, in both the first and second periods, and using contemporaneous prices for shares and futures contracts over shares (Method 3), Cannavan et al (2004) estimate the coefficient on credits at 0.16 in the first period and -0.06 in the second period (ibid, Table 3). Also, in both the first and second periods, and using a dividend drop-off methodology (Method 1), Beggs and Skeels (2006,

[11] Beggs and Skeels (2006, Table 5) also estimate the coefficient on credits at 0.57 over the period from July 2000 to 2004, but the methodology is similar to that of SFG (2013a) whilst the period examined is a subset of SFG's. Accordingly, I do not also include this result in Table 1. Also, Vo et al (2013) conduct a similar study to that of SFG (2013a). The contribution from this study is to test the sensitivity of SFG's results to various methodology changes, and has already been discussed.

[12] August 1991 and May 1997 represent dates on which distinct restrictions on the use of imputation credits took effect whilst July 1999 represents the date on which capital gains taxes were reduced (Beggs and Skeels, 2006, Appendix I). These studies are all those that are published, and involve data for multiple companies or an index, and present results based upon data for either or both of the two periods referred to.

Table 5) estimate the coefficient on credits at 0.20 for the first period and 0.42 for the second period. All of these results are shown in Table 1.

Thus, over the period August 1991 to May 1997, the estimates range from 0.16 to 0.88 across three different methods, each of which uses market data. In addition, over the period July 1997 to July 1999, the estimates range from -0.06 to 0.42 across two different methods, each of which also uses market data. Finally, over the period since July 2000, the estimates range from -1.95 to 0.54 across four different methods, each of which also uses market data. For each of these three periods, the variation in results is so great as to damage the credibility of all such estimates. Furthermore, the variation over time in results from the same methodology exhibits no consistent pattern. In particular, for method 3, the estimate falls and then rises, which is consistent with an adverse tax change in July 1997 (the 45 day rule) and a favourable tax change in July 2000 (the tax rebate on unused credits). Unsurprisingly, both Cannavan et al (2004) and Cummings and Frino (2008) note this in support of their estimates. However, for method 1, the pattern is the opposite, with the estimate rising and then falling. The lack of a consistent pattern again damages the credibility of all such estimates.

Finally, in all of these approaches, the results are significantly affected by the presence of foreign investors. This is explicit in the case of the equity ownership approach and redemption rates, and implicit in the case of market prices. However the presence of such investors is inconsistent with the Officer CAPM, which assumes complete segmentation of national equity markets. A pragmatic response to this might be to argue that the shortcoming from use of a model that implicitly (and wrongly) ignores foreign investors should not be compounded by using an estimate of theta that also fails to reflect the same phenomenon. However, the resulting estimate for the cost of equity should lie between the results that would arise under complete segmentation and under complete integration of national markets for equities. Otherwise, the recognition of foreign investors would effectively constitute cherry-picking that maximises the revenue or price cap, i.e., ignoring foreign investors when it is favourable to regulated firms (choosing the CAPM) and also estimating theta by a methodology that reflects the presence of these investors when it is also favourable to regulated firms. Lally (2013a, section 3.7) examines this issue and concludes that these approaches fail this test in virtually every case examined, and are therefore deficient. By contrast, if the Officer model were combined with a theta value of 1, or close to it, the test described here would be satisfied in most cases. All of this suggests that, if the Officer model is used, the only sensible estimate of theta is at or close to 1.

In summary, there are a number of methods of estimating theta. Given that the CAPM that is being used (the Officer version) assumes complete segmentation of national equity markets and such a situation would imply that all investors could use the credits, the natural choice for theta is 1 despite the empirical fact that many investors in Australian equities are foreigners who cannot use the credits. Furthermore, given that national equity markets are partly integrated, estimating theta at 1 seems to be the only approach that leads to estimates of the cost of equity that will typically lie within the range arising under complete segmentation and complete integration of national equity markets. If this approach is not adopted, and foreign investors are recognized when estimating theta, they ought to be also recognized in defining theta and therefore the natural estimate for theta is the proportion of Australian equities held by local investors. With this approach, I favour the use of all equity rather than only listed equity and therefore an estimate for theta of at least 60%. The existence of any (successful) tax-trading around ex days would raise theta above the proportion of Australian equities held by local investors whilst consideration of the additional terms in equation (8) would have the opposite effect. The net effect of these two forces is unclear. So, any estimate of theta of this type is subject to errors in either direction and therefore is *not* an upper bound on an estimate of theta.

The next possible approach to estimating theta, conditional upon recognizing the existence of foreign investors, is the redemption rate for imputation credits. If correctly measured, this rate would overestimate theta both because local investors would tilt towards stocks with high imputation credit yields and also because of the additional terms in equation (8). Furthermore, the ATO data from which the redemption rate is estimated contains significant unexplained discrepancies, which give rise to two significantly different estimates of the redemption rate. Accordingly, any estimate of theta of this type is very unreliable.

The next possible approach to estimating theta, conditional upon recognizing the existence of foreign investors, is the use of market prices to estimate the value of the credits. The conditions under which the use of market prices would generate an unbiased estimate of theta are very unrealistic and therefore it is highly likely that the estimates are biased (but of unknown direction). In addition, such estimates are highly variable according to the type of market data that is used (with dividend drop-off studies being merely one such type), the choice of statistical model, the criteria for selecting data, and the treatment of outliers in the data. On both counts, these estimates of theta are highly undesirable and likely to be even worse than the redemption rate.

In conclusion, my rank ordering of theta estimates is 1, followed by the proportion of Australian equity held by local investors, followed by the redemption rate for credits, and lastly the use of market prices to value the credits.

2.3 Estimation of the Distribution Rate

In estimating the distribution rate, the first question to resolve is whether estimates of the distribution rate should be based upon the same data set as that for theta. As discussed in section 2.1, the distribution rate is a firm-specific parameter whilst theta is a market parameter. Thus, theta must be estimated using market-wide data whilst the distribution rate could be estimated using firm, industry, or sector-wide data according to which was judged to provide the best estimate for this firm-specific parameter. In short, consistency is *not* essential but nor is it precluded.

Turning now to the type of data that might be used, as argued in Lally (2013a, section 4.2), estimates of the distribution rate for a firm based only on its data are subject to the difficulty that, if the firm's dividends are fully franked, then it will be able to manipulate (raise) its price or revenue cap by reducing its dividends (so as to reduce its distributed credits, which lowers its distribution rate and therefore raises its cost of capital estimated from the Officer model used by regulators). An alternative would then be some kind of industry average, and the relevant industry is regulated businesses. However many of them are publicly owned and do not pay dividends. Another alternative would then be to examine a set of large private-sector Australian firms that contain significant regulated businesses. However the set of firms is not large and therefore the choice of whether or not to include certain marginal cases is likely to materially affect the resulting estimate. All of this points to the use of some type of market-wide data. However there is considerable variation in the distribution rates across firms (see Lally, 2014, Table 2) and therefore any market-wide average could be a poor indicator of the situation for any firm. This issue could be framed as a trade-off between statistical reliability (greater from a market-wide estimate) versus potential bias (worse from a market-wide estimate).[13] The same point arises in estimating the asset beta and the leverage of the benchmark firm. Since regulators use industry rather than market averages in these cases, consistency might suggest the same decision in respect of the distribution rate. However the proper choice depends upon the severity of the bias and statistical reliability problems in each of these areas, and different decisions might be warranted.

Turning to market-wide averages, the principal choice here is between all equity or only listed equity. This matters because the difference in distribution rates is quite substantial: Frontier Economics (2016b, Table 4) reports estimates of about 50% for unlisted firms and 75% for listed firms, and Lally (2014, Table 2) estimates the rate at 84% for the largest 20 listed firms in Australia. Since it is always sensible to distribute credits if possible, and the only restriction on doing so is the size of the firm's cash dividends, the presumed cause of the difference in distribution rates between listed and unlisted firms is lower dividend payout rates in unlisted companies. Handley (2014, page 28) argues that unlisted equity should be ignored because such companies "by definition are financed in entirely different ways". Handley does not elaborate on this comment. However, he may be alluding to the fact that listed companies are generally widely held, and therefore most shareholders have very little knowledge of the actual state of affairs within these companies. Accordingly, dividends can be used to credibly signal the true state of affairs and the higher the dividend the stronger the signal of the firm's profits (Copeland et al, 2005, Ch. 16). These considerations are much less pronounced for unlisted companies, which might explain the lower payout rate and hence the lower distribution rate for imputation credits. The extreme case of this is sole traders who have corporatized in order to reduce their tax bill, and this requires a low dividend payout rate. Furthermore, privately-owned regulated businesses in Australia are typically listed firms or subsidiaries of listed firms. In respect of the QCA, the privately-owned regulated businesses are Aurizon Network (listed in Australia) and DBCT Management (ultimately owned by BIP, which is listed in the US and Canada). In respect of the ERA, the privately-owned businesses are the DBP, which is owned by the DUET Group (listed in Australia), the GGP, which is 88% owned by APA (listed in Australia), and the Midwest South West Gas Distribution System, which is owned by ATCO Gas Australia, who in turn is owned by the

[13] Bias will arise if industry or market-level data are used because the parameter value varies over firms. Industry-level data is likely to be less biased because firms within the same industry are likely to be less variable than firms in general.

ATCO Group (listed in Canada). So, the appropriate set of firms to use to estimate the distribution rate of regulated businesses is listed firms.

The final question is whether to use ATO data on all listed equity or financial statement data from a subset of high value firms whose collective value constitutes the majority of listed equity. This issue is also significant; as noted above, Frontier Economics (2016b, Table 4) reports an estimate of 75% for listed firms, and Lally (2014, Table 2) estimates the rate at 84% for the largest 20 listed firms in Australia, with further analysis in Lally (2015b, Table 1) yielding 83%. Prima facie, the ATO data are preferable because they cover all listed companies. However, there are significant problems with the ATO data (Lally, 2014b, section 8.1) and these problems are avoided by use of financial statement data. In particular, financial statement data has three features that virtually guarantee protection against the problems in the ATO data: the financial statement data is audited, the researcher is able to personally identify the source data (the figures of interest for particular firms) rather than having to rely upon the aggregation exercise carried out by the ATO (and is therefore protected against double-counting and other aggregation problems), and the financial statement data is internally consistent, i.e., there are no unexplained discrepancies in the financial statement data whereas there are major inconsistencies in the ATO data (which casts doubt on all of it).

Frontier Economics (2016b, section 2.3) argues that these large firms should be excluded because they have foreign-sourced profits that elevate their distribution rate for credits (by raising their dividends and hence the maximum credits they can attach but not the imputation credits that they create), and foreign-sourced profits are not a feature of the businesses that are being regulated (pure plays operating only within Australia). Frontier does not offer any empirical evidence on this question but it can be empirically assessed. Amongst the 20 firms examined by Lally (2015b, Table 1), the seven with the largest tax payments to the ATO account for 79% of the taxes paid to the ATO by this set of 20 firms, and I will therefore focus upon these seven. Table 2 below shows their distribution rates for credits (from Lally, 2015b, Table 1), an estimate of the proportion of profit from their foreign operations (from the 2015 Annual Report), and the payout rate (dividends to cash flow from operations, from the Cash Flow Statement in the 2015 Annual Report).[14] The proportion of profit from foreign operations is monotonically decreasing in the distribution rate, which is in the opposite direction to that claimed by Frontier, and the correlation between the two variables is the very striking figure of -0.95. Furthermore, the payout rate is positively correlated with the distribution rate (0.50).

Table 2: Distribution Rates and Foreign Operations

Company	*F*	Foreign Ops	Payout
BHP	0.64	0.50	0.26
Telstra	1.00	0.06	0.43
Westpac	0.94	0.12	0.56
CBA	0.98	0.12	0.50
NAB	0.93	0.19	0.41
ANZ	0.98	0.15	0.24
Rio Tinto	0.26	0.60	0.29

A possible explanation for these results is as follows. Firms with a large proportion of their profit from foreign operations (like BHP and Rio Tinto) retain a larger proportion of their cash flow in order to finance such operations, which reduces dividends and hence the distribution rate by more than the profits from these operations raise dividends in the same year, at least for many years. This can be modelled with a simple example. Suppose a firm has pre-tax profit of $100 (all from Australia), pays tax to the ATO of $30, and pays the $70 residue as a dividend. All $30 of the credits created can then be attached to the dividend, and therefore the distribution rate for the credits is 1. Now suppose the firm retains 30% of the

[14] The data sources are BHP (2015), Telstra (2015), Westpac (2015), CBA (2015), NAB (2015), ANZ (2015), and Rio Tinto (2015). For BHP, the profit share from foreign operations is proxied by the proportion of foreign employees, shown on page 47 of the Annual Report, and averaged over the last three years. For Telstra, the profit share from foreign operations is proxied by the proportion of foreign customers, shown on page 97 of the Annual Report, and averaged over the last two years. For Westpac, the profit share from foreign operations (NZ) is provided on page v of the Annual Report, for the latest year. For CBA, the profit share from foreign operations (NZ and IFS) is shown on page 10 of the Annual Report, and averaged over the last two years. For NAB, the profit share from foreign operations (NZ and UK) is shown on page 6 of the Annual Report, and averaged over the last two years. For ANZ, the profit share from foreign operations (NZ) is shown on pp. 24-27 of the Annual Report, and averaged over the last two years. For Rio Tinto, the profit share from foreign operations is proxied by the proportion of foreign employees, shown on page 158 of the Annual Report, and averaged over the last three years.

after-tax profit every year to invest in foreign operations, and every such $1 invested generates an increment to pre-tax profit of $0.1 per year thereafter. The firm's distribution rate will then initially fall to 70% as follows:

$$F = \frac{Dist}{TAX(ATO)} = \frac{DIV(3/7)}{TAX(ATO)} = \frac{\$70(.7)(3/7)}{\$30} = .70$$

The denominator here will remain fixed over time whilst the pre-tax profits (and hence the numerator here) will rise at 2.1% per year (0.70*0.30*0.10). So, the distribution rate will rise over time at the same rate, and will take 17 years to recover to the original level of 1. So, Frontier's claim seems to be false and an explanation for the opposite pattern is readily apparent.

In summary, since the distribution rate is a firm-specific parameter whilst theta is a market parameter, theta must be estimated using market-wide data whilst the distribution rate could be estimated using firm, industry, or market-wide data according to which was judged to provide the best estimate for this firm-specific parameter. So, consistency is *not* essential. Furthermore, pragmatic considerations point to the use of market-wide data of some sort. Since the distribution rates for listed and unlisted businesses are significantly different and (private) regulated businesses are typically listed or owned by listed parents, the distribution rate for regulated businesses should be estimated from that of listed equity. The choices here are ATO data on all listed equity or financial statement data on a subset of high value firms constituting a majority of the value of listed equity. Since the ATO data contains significant unresolved discrepancies, this favours the use of financial statements for a subset of high value firms and an estimate of this type is 0.83 for the top 20 such firms. Finally, Frontier's claim that firms with significant foreign operations have higher distribution rates than firms without such operations, and are therefore unsuitable for estimating the distribution rate of regulated businesses (which do not have foreign operations), appears to be false and the observed pattern can be explained through the investment of profits required to finance these foreign operations. Accordingly, the effect of these firms with foreign operations being included within the set of firms used to estimate the distribution rate for the benchmark firm (with only local operations) is to underestimate rather than overestimate the distribution rate for the benchmark firm. Thus, the estimate for the distribution rate of 0.83 is likely to be too low for the benchmark firm rather than too high.

3. Review of the ACT's Views on Theta

The ACT (2016, para 1094, 1096) argues that theta is the market value of the imputation credits, and is therefore best estimated by studies using market data. This matches the view of the Network Applicants (ACT, 2016, para 1017, 1066). The source of the ACT's (2016, para 1100) belief that theta is a market value is claimed to be the Officer model but the ACT fails to explain at what point this conclusion is apparent in Officer's analysis. By contrast, in section 2.1, I show that Officer clearly does not define theta as a market value. In addition, I explain that this is secondary in any case, because Officer does not provide a formal derivation of his model and therefore one must look to papers that do provide that. I also note that Lally and van Zijl (2003, section 3) provide a formal derivation of a generalisation of Officer's model (with the Officer model being a special case). In this derivation, they show that theta is a complex weighted average over the "utilization" rates for imputation credits of all investors holding risky assets, where the weights involve each investor's investment in risky assets and other terms, and that the utilization rate for an investor is their ability to use the credits to reduce their tax obligations (1 if the investor is able to fully use the credits and 0 if they are unable to use the credits). This matches the AER's view (ACT, 2016, para 1038).

The ACT (2016, paras 1075-1076) does refer to Lally and van Zijl (2003) on the question of how theta is defined, but claims that the definition of theta in this paper is not relevant to Officer because the Lally and van Zijl model is a generalization of the Officer model. It is correct that Lally and van Zijl (2003, section 3) is a generalization of Officer, in the sense of allowing (but not requiring) the personal tax rates on capital gains and dividends to differ whereas Officer implicitly assumes that these tax rates are equal. However, the Officer model is then a special case of Lally and van Zijl, and therefore Lally and van Zijl provides a derivation of the Officer model merely by imposing the Officer assumption at all relevant points in the proof, i.e., $T_{pi} = T_{gi}$ for each investor i in the notation of Lally and van Zijl. In doing this, the definition of theta as shown in equation (2) above is *not* affected because it does not contain both of these tax rates. Furthermore, Lally and van Zijl (2003, page 189) explicitly state this. So, contrary to the ACT's belief, Lally and van Zijl (2003, section 3) does provide a derivation of the Officer model (as well as a proof of a generalization of it) and theta is defined there as a complex weighted average over the "utilization" rates for imputation credits of all investors holding risky assets, where the weights involve each investor's investment in risky assets and other terms, and the utilization rate for an investor is their ability to use the credits to reduce their tax obligations; $U_i = 1$ if the investor is able to fully use the credits and 0 if they are unable to use the credits. So, theta is not a market value. Since this undercuts the ACT's crucial point, it undercuts their entire line of reasoning.

The ACT (2016, para 1073, 1097) also argues that defining theta as a market value, and therefore estimating it using market data, is consistent with the processes for estimating the costs of debt and equity from market data. This could be interpreted as claiming that theta must be a market value because the costs of debt and equity are market values. Both the cost of equity and theta appear in equation (1), with the cost of equity being a market rate and theta *not* being a market value. This equation arises from the set of assumptions underlying the Officer (1994) model. So, there is no inconsistency within the model arising from theta not being a market value whilst the costs of debt and equity are. The model comprises some parameters that are market values (such as the cost of equity) and others that are not (such as the corporate tax liabilities and theta). However, the market cost of equity reflects the actual model used by investors to value assets. If the model chosen by a regulator differs from this, then there will be an inconsistency between empirically determined estimates of the cost of equity and the model into which they are inserted. One example of this problem is administrative costs associated with using imputation credits. In the presence of imputation credits, the market cost of equity exclusive of the credits will fall in recognition of the credits. So, as the administrative costs associated with the credits rise, so too will the market cost of equity. So, any empirically determined cost of equity will reflect the extent of these costs. However, as discussed in section 2.1, the Officer model does not recognize these costs in the structure of the model. This is an inconsistency between the model and empirical estimates of its parameters, but as discussed in section 2.1 could only be resolved by an extension to the Officer model (rather than by modifying the definition of theta) and would not warrant the effort because the costs are so small and most of them are dealt with through the empirical estimate of the MRP. Furthermore, all valuation models make assumptions, many of these are not entirely realistic, and these administrative costs associated with imputation credits are likely to be one of the least important such discrepancies. A much more important discrepancy here is that market determined costs of equity will reflect the presence of foreign investors in the Australian market whilst the Officer (1994) model assumes that the Australian equity market is segregated from other equity markets. In addition, since capital gains are taxed less heavily at the personal level in Australia than dividends, the market cost of equity is likely to reflect this differential personal tax treatment whilst the Officer (1994) model implicitly assumes that both types of income are equally taxed at the personal level.

The ACT (2016, para 1103) also provisionally concludes that the best estimate of theta is that provided by SFG (2013a), of 0.35. Given the ACT's view that theta is the market value of the credits, it follows that the ACT would prefer market studies to other types of evidence. However, the ACT fails to explain why they prefer a dividend drop-off study to any of the other three market methodologies whose results are shown in the last column of Table 1 above. Furthermore, even if the ACT had explained their preference for divided drop-off studies, they fail to explain why they prefer the SFG (2013a) study to that of Vo et al (2013). Furthermore, even if they had explained their preference for SFG, they fail to explain why they prefer the methodology favoured by SFG. Inter alia, that methodology involves "robust regression" with the default value for the tuning coefficient and Vo et al (2013) show that alternative choices for that coefficient produce significantly different estimates of the coefficient on imputation credits. So, implicitly, the ACT favours the default option for this tuning coefficient but fails to explain why. In addition, the credibility of any statistical estimates depends upon how robust they are to the deletion of outliers and SFG's results are robust to the deletion of outliers if SFG's method of selecting them is adopted. By contrast, Vo et al's (2013) results are not robust to the deletion of outliers using a different method of choosing them. This implies that SFG's results would not be robust to the deletion of outliers if they were chosen by the Vo et al method. So, implicitly, the ACT favours SFG's method of deleting outliers but fails to explain why. In addition, any estimate of theta from a dividend drop-off study is sensitive to the degree of tax arbitrage, anomalous behavior around ex-days, and bouncing between bid and ask. So, implicitly, the ACT favours an estimate of theta that is exposed to all of these extraneous factors but fails to explain why.

The only aspect of SFG's estimate of 0.35 that the ACT (2016, para 1102) does comment on is the question of whether the estimated coefficient on the credits should be divided by the estimated coefficient on the cash dividends, as explained by Lally (2013b, pp. 20-21). In response to this argument, the ACT approvingly quotes from SFG, who dismisses the argument because it is based upon the belief that the coefficient on cash dividends is less than 1 due to an "econometric bias". However, Lally (2013b, pp. 20-21) argues that the coefficient on cash dividends is less than 1 because capital gains are taxed less onerously than dividends, and the same is true for the valuation of the imputation credits. This is a tax issue, *not* an econometric issue.

The ACT (2016, para 1093, 1095, 1066) also argues that the redemption rate and the estimate from the equity ownership approach are upper bounds on the estimate of theta, due to time delays, administrative costs in distributing the credits, portfolio effects, and the effect of the 45 day rule. Given their belief that theta is the market value of the credits, this would seem to follow. However, their belief about theta is wrong: theta is not the market value of the credits, and this alone undercuts the reasoning. In addition, even if theta were the market value of the credits, the belief that the equity ownership proportion necessarily exceeds the market value of the credits due to administrative costs, time delays, portfolio effects, etc is wrong. For example, if 50% of Australian equities were foreign owned, tax arbitrage involving local investors buying shares shortly before dividend ex-days and selling them shortly afterwards could lead to all credits being redeemed by locals and therefore the market value on the credits could be close to 1.0. So, the market value of the credits may be above the proportion of equity owned by Australian investors.

In summary, the ACT (consistent with the view of the Network Applicants) believes that theta is the market value of the imputation credits, and is therefore best estimated by studies using market data. However this view that theta is the market value of the credits is not supported by any statement in the Officer paper nor by any rigorous derivation of the model. On the contrary, rigorous derivations show that theta is a complex weighted average over the utilization rates for credits by investors, with the utilization rate being the eligibility to use the credits. Thus, estimates of the market value of the credits are not the natural method for estimating theta. Instead their usefulness along with that of alternative methods for estimating theta must be assessed by how well they compare with the definition of theta. As discussed above, estimates of the market value of the credits are biased and highly variable estimators, and are inferior to all other estimation methods that have been discussed. In addition, and in respect of the ACT's apparent belief that theta is a market value because the costs of debt and equity are market values, there is no inconsistency within the Officer model arising from theta not being a market value whilst the costs of debt and equity are. The model comprises some parameters that are market values (such as the cost of equity) and others that are not (such as the corporate tax liabilities and theta). Furthermore, and in respect of the ACT's view that the best estimate of theta is 0.35 from SFG's dividend drop-off study, it is understandable in view of the ACT's view that theta is the market value of the credits that it prefers market studies to other types of evidence. However, the ACT fails to explain why they prefer a dividend drop-off study to any of the other three methodologies that have been used, nor do they explain why they prefer the SFG study to a more recent dividend drop-off study by other authors, nor do they explain why they prefer "robust regression" with the default value for the tuning coefficient, nor do they explain why they prefer SFG's method for deleting outliers over the alternative method in this other paper. In addition, the ACT fails to explain their acceptance of results from a methodology that is highly sensitive to a number of irrelevant factors such as the degree of tax arbitrage, anomalous behavior around ex-days, and bouncing between the bid and ask prices. Finally, and in relation to the ACT's view that the redemption rate and the estimate from the equity ownership approach are upper bounds on the estimate of theta, due to time delays, administrative costs in distributing the credits, portfolio effects, and the effect of the 45 day rule, this might seem to follow from their view that theta is the market value of the credits. However, theta is not the market value of the credits, and this alone undercuts this reasoning. In addition, even if theta were the market value of the credits, the belief that the equity ownership proportion is necessarily above the market value of the credits due to administrative costs, time delays, portfolio effects, etc is wrong. For example, if 50% of Australian equities were foreign owned, tax arbitrage involving local investors buying shares shortly before dividend ex-days and selling them shortly afterwards could lead to all credits being redeemed by locals and therefore the market value on the credits could be above 0.50.

4. Review of The ACT's Views on the Distribution Rate

In relation to the distribution rate, the ACT (2016, para 1106) states that "it is appropriate to follow past practice", and this leads to an estimate of 0.70 for all equities using ATO data. The ACT offers no reason for doing so, and therefore there is no reasoning to critique. In respect of the conclusion, the ATO data is flawed, and even the ACT (2016, para 1092) accept this. So, as described in section 2.3, I favour the use of financial statement data from the 20 largest firms to estimate the distribution rate.

The ACT (2016, para 1106) rejects the AER's view on the need for consistency in the type of data used to estimate theta and the distribution rate. As indicated in section 2.3, theta must be estimated using market-wide data whilst the distribution rate could be estimated using firm, industry, or sector-wide data according to which was judged to provide the best estimate for this firm-specific parameter. So, consistency is *not* essential but nor is it precluded. Accordingly, like the ACT, I reject the AER's position. However, this does not imply any particular value for the distribution rate, and therefore does not support past practice.

In summary, the ACT's preference for past practice leads to an estimate of 0.70 for all equities using ATO data, but is not supported by any reasoning from them. My own views are expressed in section 2.3: the distribution rate is best estimated using data from listed companies and in particular from the financial statements of the 20 largest listed firms, leading to an estimate of at least 0.83.

5. Conclusions

My principal conclusions are as follows. Firstly, in respect of the Officer model, rigorous proofs of the model reveal that theta is a weighted average over the utilization rates for imputation credits by individual investors and these utilization rates are 1 if investors can fully use the credits to reduce their tax obligations and zero if they cannot use them. So, theta is not the market value of the credits. Transactions and administrative costs incurred by investors in dealing with these credits cannot be dealt with by reducing the estimate for theta and, if considered important (which I do not think to be the case) would have to be addressed through an extension to the Officer model. Furthermore, this extension would only matter to the extent that the firm's equity beta differed from 1. Otherwise, such costs that are reflected in the empirical estimate for the MRP that is used by the regulator would deal with this issue. In addition, the definition of theta as a weighted average over utilization rates is consistent with the way in which company taxes are treated in tax regimes without imputation.

Secondly, and in respect of estimating theta, since the CAPM that is being used (the Officer version) assumes complete segmentation of national equity markets and this implies that all investors could use the credits, the natural choice for theta is 1 despite the empirical fact that many investors in Australian equities are foreigners who cannot use the credits. Furthermore, given that national equity markets are partly integrated, estimating theta at 1 seems to be the only approach that leads to estimates of the cost of equity that will typically lie within the range arising under complete segmentation and complete integration of national equity markets.

Thirdly, if this approach to estimating theta is not adopted and foreign investors are recognized when estimating theta, they ought to be also recognized in defining theta and therefore the natural estimate for theta is the proportion of Australian equities held by local investors. With this approach, I favour the use of all equity rather than only listed equity and therefore an estimate for theta of at least 60%. This conclusion is strengthened by the existence of any (successful) tax-trading around ex days, which would raise theta above the proportion of Australian equities held by local investors, whilst consideration of terms other than market weights in the formula for theta would have the opposite effect. The net effect of these two forces is unclear. So, any estimate of theta of this type is subject to errors in either direction and therefore is *not* an upper bound on an estimate of theta.

Fourthly, and again conditional upon recognizing the existence of foreign investors, my next preferred method for estimating theta is the redemption rate for imputation credits. If correctly measured, this rate would overestimate theta because local investors would tilt towards stocks with high imputation credit yields and also because of terms other than market weights in the formula for theta. Furthermore, the ATO data from which the redemption rate is estimated contains significant unexplained discrepancies, which give rise to two significantly different estimates of the redemption rate. Accordingly, any estimate of theta of this type is very unreliable, and therefore inferior to the proportion of Australian equities held by local investors.

Fifthly, and again conditional upon recognizing the existence of foreign investors, my least preferred method for estimating theta is the use of market prices to estimate the value of the credits. The conditions under which the use of market prices would generate an unbiased estimate of theta are very unrealistic and therefore it is highly likely that the estimates are biased (but of unknown direction). In addition, such estimates are highly variable according to the type of market data that is used (with dividend drop-off studies being merely one such type), the choice of statistical model, the criteria for selecting data, and the treatment of outliers in the data. On both counts, these estimates of theta are highly undesirable and likely to be even worse than the redemption rate.

Sixthly, and in respect of the distribution rate, since it is a firm-specific parameter whilst theta is a market parameter, theta must be estimated using market-wide data whilst the distribution rate could be estimated using firm, industry, or market-wide data according to which was judged to provide the best estimate for this firm-specific parameter. So, consistency is *not* essential. Furthermore, pragmatic considerations point to the use of market-wide data of some sort. Since the distribution rates for listed and unlisted businesses are significantly different and (private) regulated businesses are listed or owned by listed parents, the distribution rate for regulated businesses should be estimated from that of listed equity. The choices here are ATO data on all listed equity or financial statement data on a subset of high value firms constituting a majority of the value of listed equity. Since the ATO data contains significant unresolved discrepancies, this favours the use of financial statements for a subset of high value firms and an estimate of this type is 0.83 for the top 20 such firms. Many of these firms have significant foreign operations, which are irrelevant to an estimate of the distribution rate for regulated businesses. The effect of this feature of these firms is to underestimate rather than overestimate the distribution rate for the benchmark firm. Thus, the appropriate estimate for the distribution rate for the benchmark firm is at least 0.83.

Seventhly, and in relation to the ACT's views on theta, the ACT (consistent with the view of the Network Applicants) believes that theta is the market value of the imputation credits, and is therefore best estimated by studies using market data. However, this view that theta is the market value of the credits is not supported by any statement in the Officer paper nor by any rigorous derivation of the model. On the contrary, rigorous derivations show that theta is a complex weighted average over the utilization rates for credits by investors, with the utilization rate being the eligibility to use the credits. Thus, estimates of the market value of the credits are not the natural method for estimating theta. Instead their usefulness along with that of alternative methods for estimating theta must be assessed by how well they compare with the definition of theta. As discussed above, estimates of the market value of the credits are biased and highly variable estimators, and are inferior to all other estimation methods that have been discussed.

In addition, and in respect of the ACT's apparent belief that theta is a market value because the costs of debt and equity are market values, there is no inconsistency within the Officer model arising from theta not being a market value whilst the costs of debt and equity are. The model comprises some parameters that are market values (such as the cost of equity) and others that are not (such as the corporate tax liabilities and theta).

Furthermore, and in respect of the ACT's view that the best estimate of theta is 0.35 from SFG's dividend drop-off study, it is understandable in view of the ACT's view that theta is the market value of the credits that it prefers market studies to other types of evidence. However, the ACT fails to explain why they prefer a dividend drop-off study to any of the other three market study methodologies that have been used, nor do they explain why they prefer the SFG study to a more recent dividend drop-off study by other authors, nor do they explain why they prefer "robust regression" with the default value for the tuning coefficient, nor do they explain why they prefer SFG's method for deleting outliers over the alternative method in this other paper. In addition, the ACT fails to explain their acceptance of results from a methodology that is highly sensitive to a number of irrelevant factors such as the degree of tax arbitrage, anomalous behavior around ex-days, and bouncing between the bid and ask prices.

Furthermore, and in relation to the ACT's view that the redemption rate and the estimate from the equity ownership approach are upper bounds on the estimate of theta, due to time delays, administrative costs in distributing the credits, portfolio effects, and the effect of the 45 day rule, this might seem to follow from their view that theta is the market value of the credits. However, theta is not the market value of the credits, and this alone undercuts this reasoning. In addition, even if theta were the market value of the credits, the belief that the equity ownership proportion is necessarily above the market value of the credits due to administrative costs, time delays, portfolio effects, etc is wrong. For example, if 50% of Australian equities were foreign owned, tax arbitrage involving local investors buying shares shortly before dividend ex-days and selling them shortly afterwards could lead to all credits being redeemed by locals and therefore the market value on the credits could be above 0.50.

Lastly, and in relation to the ACT's views on the distribution rate, the ACT's preference for past practice leads to an estimate of 0.70 for all equities using ATO data, but is not supported by any reasoning from them. My own views are expressed above: the distribution rate is best estimated using data from listed companies and in particular from the financial statements of the 20 largest listed firms, leading to an estimate of at least 0.83.

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