

Response to Officer (2006) “FOXTEL’s special access undertaking: Issues with imputation”

Final Report

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Contents

AUTHOR AND SCOPE OF REPORT	4
ASSUMPTIONS.....	4
MATERIALS PROVIDED	4
FEDERAL COURT GUIDELINES	4
SUMMARY OF OPINIONS.....	5
1. THE DIFFERENCE BETWEEN FRANKING CREDITS (A) HAVING VALUE TO SOME SHAREHOLDERS AND (B) AFFECTING THE CORPORATE COST OF CAPITAL.....	7
1.1 Overview.....	7
1.2 Officer implies that simply because some shareholders value franking credits they must therefore affect the corporate cost of capital	7
1.3 Illustration of how franking credits affect the corporate cost of capital	8
1.4 If foreign investment is required, franking credits will not reduce the corporate cost of capital.....	9
1.5 Officer's arguments for why foreign investors do not require fair returns	9
1.6 Franking credits having some value to some shareholders does not automatically imply that they affect the corporate cost of capital.....	10
1.7 Are global institutional investors really prepared to subsidise Australian industry?.....	10
1.8 There are inconsistencies among Officer's arguments for why foreign investors do not require fair returns	10
1.9 Officer's real estate analogy is incomplete and inconsistent	11
1.10 Conclusion.....	12
2. FRANKING CREDITS MUST BE CREATED AND DISTRIBUTED IF THEY ARE TO HAVE VALUE	12
2.1 Franking credits are created by the payment of Australian corporate tax	12
2.2 Regulatory parameters are set at their present values, not expected future values.....	13
2.3 It is incorrect to suggest that setting gamma to zero implies that the firm never pays franked dividends	14
2.4 Conclusions.....	14
3. SHARE BUYBACKS AS A WAY OF DISTRIBUTING FRANKING CREDITS.....	14
3.1 Share buybacks can be used to distribute franking credits.....	14
3.2 Share buybacks can be used as a mechanism to stream franking credits.....	15
3.3 The impact of share buybacks is relatively small.....	15
3.3 Conclusions.....	16
4. EVIDENCE FROM BROKER VALUATIONS	16
4.1 Independent valuation experts and Australian firms themselves set gamma to zero.....	16
4.2 Some brokers provide valuations with and without franking credits, recognizing that some clients value franking credits and others do not.....	16
4.3 Conclusions.....	17
5. STATISTICAL ISSUES IN DIVIDEND DROP-OFF STUDIES	17
5.1 Multi-collinearity is a potential problem, affecting our ability to interpret the empirical results	17
5.2 Scaling the data does not remove multi-collinearity.....	18
5.3 The effect of multi-collinearity is an empirical question – do different sub-sets of the data produce inconsistent results?.....	19
5.4 If multi-collinearity is to be ignored, we should at least use the results that are relevant for FOXTEL.....	19

5.5 If multi-collinearity is to be ignored, we should at least ensure consistency between the empirical estimates and the model in which they are to be used.....	20
5.6 Conclusions	21
6. CRITICISM OF CANNAVAN, FINN, AND GRAY (2004)	21
6.1 A test of model mis-specification.....	21
6.2 Conclusion.....	22
7. OTHER MATTERS REQUIRING EXPLANATION	22
7.1 What is the appropriate value for gamma?	22
7.2 The relationship between gamma and dividend yield	23
7.3 Updated results	24
REFERENCES	25
SIGNATURE.....	26

Author and Scope of Report

This report has been prepared by Prof. Stephen Faulkner Gray. I am Professor of Finance in the UQ Business School at the University of Queensland. I have Honours degrees in Commerce and Law and a PhD in Finance from the Graduate School of Business at Stanford University. A copy of my CV is attached to this report as an appendix.

I have been asked to provide my views on the report of Professor Robert Officer, “FOXTEL’s special access undertaking: Issues with imputation,” February 2006.

I have previously provided a report on this topic in relation to these proceedings. That report is titled, “The effect of franking credits on FOXTEL’s cost of capital,” 4 October, 2005. I refer to that report as Gray (2005) throughout.

Assumptions

I have been asked to assume that FOXTEL’s cumulative profit is expected to be less than its accumulated losses for the majority of the regulatory period. That is, total accumulated profit is not expected to exceed the present accumulated losses until near the end of the regulatory period.

Materials Provided

I have been provided with the following materials and data:

1. The ACCC (December 2003) Section 152ATA Digital Pay TV Anticipatory Individual Exemption Application lodged by FOXTEL Management Pty Limited: Final Decision.
2. The report of Professor Robert Officer, “FOXTEL’s special access undertaking: Issues with imputation,” February 2006. I refer to this paper throughout the report as Officer (1996).
3. I also refer to a number of published papers, for which a full citation is provided within the body of the report.

Federal Court Guidelines

I have been provided with the “Guidelines for Expert Witnesses in Proceedings in the Federal Court”. This report has been prepared in a way that is consistent with those Guidelines.

Summary of opinions

My opinions and conclusion in relation to the arguments in Officer (2006) are as follows:

1. Setting gamma above zero implies that investors who cannot use franking credits will receive a lower than fair return. This is not a question of estimation or interpretation or supposition, it is a direct unambiguous mathematical consequence of Officer (1994). Therefore, **setting gamma above zero requires an explanation of why non-resident investors would commit capital to the Australian market if they expected lower than fair returns.** Three such reasons are proposed in Officer (2006). In my opinion, these arguments are inconsistent with one another and imply economically implausible consequences. However, my conclusion is that the impact of franking credits on the corporate cost of capital should not be determined by reference to various conceptual arguments but rather by reference to empirical data. **It is not possible to determine an appropriate value for gamma by reference to conceptual arguments alone. Rather, empirical evidence should be examined first,** and the conclusions from this analysis tested against conceptual reasoning. This is the approach adopted in Gray (2005), where I argue that the proper interpretation of the empirical evidence is that gamma should be set to zero, and then I explain conceptually that this result is the only one that is consistent with foreign investment in Australia earning a fair return.
2. If regulated prices are set on the basis of an assumed positive value for gamma, even though no franking credits will be distributed during the regulatory period, it is impossible for shareholders to earn a fair expected return. Such a price-setting arrangement assumes that prices (and returns to shareholders) can be lower because shareholders can make up the shortfall by way of receiving (assumed) valuable franking credits. If no franking credits will be paid, the shortfall cannot be made up and shareholders will receive a lower than fair expected return.
3. Share buybacks do present a method for firms to channel franking credits to those shareholders who do value them. This provides firms with a method of extracting some value from the credits. However, the effect is economically small and cannot be used to justify standard regulatory assumptions about the value of gamma. Moreover, it is fanciful that a firm that has substantial accumulated losses and has never recorded a profit would even consider a buyback. Buybacks are a mechanism for returning surplus capital to shareholders – few would consider FOXTEL to have surplus capital.
4. **Evidence from broker research simply suggests that brokers believe that some of their clients value franking credits and others do not. But we already knew this to be the case.** The question of whether franking credits affect the corporate cost of capital is quite different. That will depend on equilibrium considerations and is ultimately an empirical question.
5. It is generally recognised and agreed that multi-collinearity is a potential problem when regressing stock price changes on dividends and franking credits. Officer argues that scaling the data by the amount of the dividend eliminates the problem of multi-collinearity. As a general statistical principle, I do not believe that scaling data eliminates multi-collinearity. Moreover, the parameter estimates vary considerably across different data sets and there is no economically plausible reason for this. This is exactly what would be expected if multi-collinearity were present. If, however, the results are to be taken at face value, one should use the results from firms similar to

FOXTEL. For firms outside the top 100, Hathaway and Officer find little evidence that franking credits are valued by the relevant investor at all. We should also use results that are consistent with the model they are to be used in. The standard CAPM assumes that dividends and franking credits are equally valued. Consequently, we should impose this restriction before estimating the value of franking credits. Bellamy and Gray (2004) show that when this is done, the results imply that franking credits are not valued by the relevant investor. Moreover, this restricted model fits the data as well as any unrestricted model estimated by Hathaway and Officer. **Results from dividend drop-off studies cannot be used to justify setting gamma above zero.**

6. Officer (2006) argues that the results of Cannavan, Finn, and Gray (2004) may be contaminated by model mis-specification error. However, a comprehensive check for model mis-specification was performed by the authors and reported in that paper. **This demonstrated, to the satisfaction of the editors and referees of one of the leading finance journals, that model mis-specification error has not contaminated their results.**
7. It is simply not possible for FOXTEL to distribute franking credits sufficient to justify setting gamma to 0.5.
8. The range of possible values that could be contemplated for gamma would have a lower bound of zero, based on the estimates of Cannavan, Finn, and Gray (2004) and Bellamy and Gray (2004) and consistent with the conceptual equilibrium arguments in this report. The upper bound would be 0.35, and would only be justified in the case where it could be shown that the Hathaway-Officer results are not contaminated by statistical problems and where consistency between the model and the estimation technique were not required.

1. The difference between franking credits (a) having value to some shareholders and (b) affecting the corporate cost of capital.

1.1 Overview

Officer (2006) implies that because franking credits have value for some shareholders, it automatically follows that they must affect the corporate cost of capital. However, showing that franking credits have value to some investors is not the same as showing that franking credits affect the corporate cost of capital. These are entirely different concepts and one does not necessarily follow from the other.

To establish this, I begin by reviewing the framework developed by Officer (1994). This framework establishes how it is that franking credits might affect the corporate cost of capital. I then consider a scenario in which foreign investment is required and Australian firms are required to provide fair returns to these foreign investors in order to attract the required capital from them. I show that in this scenario, and using the Officer (1994) framework, that franking credits do not affect the corporate cost of capital even though they might be valuable to some investors.

Officer (2006) provides three arguments against this reasoning:

1. We see some franking credits being redeemed by resident investors, therefore they simply must affect the corporate cost of capital;
2. Non-resident investors are forced to invest in Australia even though they receive less than a fair return; and
3. Non-resident investors can sell their shares to Australian residents who will capitalise the value of franking credits into the price. Therefore, non-residents only miss out on the value of franking credits *while they hold the stock* and this is a relatively minor cost.

In this section, I examine each of these arguments and demonstrate the inconsistencies between them and show that they imply economically implausible consequences.

However, my conclusion is that the impact of franking credits on the corporate cost of capital should not be determined by reference to various conceptual arguments but rather by reference to empirical data. It is not possible to determine an appropriate value for gamma by reference to conceptual arguments alone. Rather, empirical evidence should be examined first, and the conclusions from this analysis tested against conceptual reasoning. This is the approach adopted in Gray (2005), where I argue that the proper interpretation of the empirical evidence is that gamma should be set to zero, and then I explain conceptually that this result is the only one that is consistent with foreign investment in Australia earning a fair return.

1.2 Officer implies that simply because some shareholders value franking credits they must therefore affect the corporate cost of capital

Officer (2006) implies that because franking credits have value for some shareholders, it automatically follows that they must affect the corporate cost of capital. For example:

“Franking credits reduce the tax liabilities of Australian investors and effectively reduce the company tax rate. This indicates that franking credits do have value...So franking credits do affect the cost of capital.” [page 7].

Similarly,

“Franking credits are a form of pre-payment of one’s personal tax liability and, accordingly, I believe that franking credits do affect the cost of capital for Australian listed firms.” [page 9].

Consistent with this, Officer (p.22) notes that “shareholders have redeemed in excess of \$200 billion in franking credits since 1987” and that it must therefore follow that “franking credits are valuable, and moreover, they will affect the cost of capital of a company.”

Furthermore, in some places Officer implies that because my original report (Gray, 2005) concludes that franking credits do not affect the cost of capital of large Australian firms, it follows that I must also conclude that franking credits are worthless to all investors:

“It is unambiguous that credits can be used to reduce the tax liabilities of Australian taxpaying investors. It is testing credibility and commonsense to believe that the credits are valueless.” [page 22].

However, showing that franking credits have value to some investors is not the same as showing that franking credits affect the corporate cost of capital. These are entirely different concepts and one does not necessarily follow from the other.

1.3 Illustration of how franking credits affect the corporate cost of capital

Officer (2006) implies that since franking credits are valued by some investors it automatically follows that they must affect the corporate cost of capital. The following example illustrates the difference between (a) franking credits having value to some investors, and (b) franking credits affecting the corporate cost of capital. Suppose that the cost of equity for a particular firm is 14%. In practice and in a regulatory determination this would usually be estimated using the Capital Asset Pricing Model. This implies that, given their assessment of the risk involved in providing equity capital to this firm, investors have determined that an expected return of 14% is appropriate. Some investors will have assessed that a higher return is warranted and others would have accepted a lower return. But 14% is an equilibrium outcome – the return that must be offered to investors to attract just enough equity capital to fully finance the firm. If the firm offered a lower return it would attract insufficient funds. If the firm offered a higher return it would attract an unnecessary surplus of funds. In this sense, the 14% return is an equilibrium outcome.

Now suppose that the relevant corporate tax rate is 30% and that gamma is set to 0.5. The parameter gamma reflects the extent to which franking credits affect the corporate cost of capital.¹ Officer (1994) has shown that the assumed value of franking credits would affect the firm’s cost of equity as follows:

¹ The value of 0.5 has been commonly used in Australian regulatory determinations, based on Hathaway and Officer (1992). Note, however, that the most recent version of this paper (using the same methodologies but an updated data set) recommends setting gamma to 0.35.

$$r_e^{adj} = r_e \frac{1-T}{1-T(1-\gamma)} = 0.14 \frac{1-.30}{1-0.3(1-0.5)} = 11.5\% .$$

This equation from Officer (1994) recognises that there are potentially three components to the shareholders' return – dividends, capital gains, and franking credits. The CAPM indicates that the total package must provide investors with a 14% expected return. The firm is responsible for generating dividends and capital gains and franking credits are provided by government (by allowing them to reduce personal tax obligations). When estimating the firm's cost of capital, we are seeking to estimate what it costs *the firm* to attract the necessary capital. What is relevant is not the entire 14% return that investors require, but how much of that must be provided by *the firm*.

In the illustration above, investors require a total return of 14%. At the assumed value of gamma, franking credits provide a return of 2.5% and the remaining 11.5% must be generated by the firm in the form of dividends and capital gains. Thus, the firm's cost of equity capital has been reduced from 14% to 11.5% through the dividend imputation system.

1.4 If foreign investment is required, franking credits will not reduce the corporate cost of capital

Officer (2006) and Gray (2005) agree that:

1. Franking credits can be (and are) used by Australian resident investors to reduce their personal tax obligations; and that
2. Franking credits that are distributed to non-resident investors cannot be redeemed by them.

In the context of the illustration above, this implies that resident investors receive dividends and franking credits to provide a return of 11.5% and that they redeem their franking credits to yield an additional 2.5%, providing the required total return of 14%.

However, non-resident investors who receive franking credits cannot redeem them. These investors, therefore, benefit from dividends and capital gains only and receive a total return of only 11.5% – less than the equilibrium required return.

Gray (2005) argues that if Australia is a net importer of capital, which it is, it must provide fair returns to attract foreign capital. That is, non-resident investors would be reluctant to commit funds expecting to earn 11.5%, when similar investments elsewhere are offering 14%. If the firm in question required foreign capital, it would have to offer dividends and capital gains sufficient to provide the entire 14% required return. Anything less would be insufficient to attract the required capital. In this setting, the firm gets no reduction in its cost of capital from the Australian dividend imputation system. The firm itself must pay the entire (globally-determined) 14% required return via dividends and capital gains. Thus, franking credits are clearly valuable to resident investors, but they do not affect the corporate cost of capital.

1.5 Officer's arguments for why foreign investors do not require fair returns

In the previous section, I considered a scenario in which foreign investment is required and Australian firms are required to provide fair returns to these foreign investors in order to attract the required capital

from them. I showed that in this scenario, and using the Officer (1994) framework, that franking credits do not affect the corporate cost of capital even though they might be valuable to some investors. Officer (2006) provides three arguments against this reasoning:

1. We see some franking credits being redeemed by resident investors, therefore they simply must affect the corporate cost of capital;
2. Non-resident investors are forced to invest in Australia even though they receive less than a fair return; and
3. Non-resident investors can sell their shares to Australian residents who will capitalise the value of franking credits into the price. Therefore, non-residents only miss out on the value of franking credits *while they hold the stock* and this is a relatively minor cost.

1.6 Franking credits having some value to some shareholders does not automatically imply that they affect the corporate cost of capital

The argument that because we see some franking credits being redeemed by resident investors, they simply must affect the corporate cost of capital is not a conceptual argument at all. In the scenario developed above, resident investors use all franking credits distributed to them yet there is no effect on the equilibrium corporate cost of capital. *It is possible that franking credits do affect the corporate cost of capital, but this must be demonstrated by reference to empirical evidence.* Simply showing that some franking credits do get used is no proof that they reduce the cost of capital – there is more to be shown.

1.7 Are global institutional investors really prepared to subsidise Australian industry?

Officer's second argument is based on the notion that much of the foreign investment in Australia comes by way of global index funds. The mandate of these funds is to match the return of a global stock index such as the MSCI. If Australia represents x% of the benchmark index, the fund must invest x% in the Australian market – even if this means earning less than a fair return.

But suppose it was really the case that Australia had access to a captive multi-billion dollar source of capital that was forced to invest here irrespective of the deals being offered. This implies that Australian firms have access to equity capital at below-market rates, and this was achieved simply by passing a law that changes the way residents are taxed on their dividend income. Is it really the case that a small country can substantially reduce the cost of its global capital by fiddling with the way it taxes the dividend income of its own citizens? If so, we should make the imputation system more generous so that we further increase the extent to which global pension funds subsidise Australian industry.

1.8 There are inconsistencies among Officer's arguments for why foreign investors do not require fair returns

Officer's second and third arguments are inconsistent. The third argument is that franking credits are valuable and that this value is capitalised into stock prices. Thus, when buying Australian shares non-resident investors must pay for franking credits that they cannot use. However, when later selling the stock, the sale price will also reflect the capitalised value of future credits. Thus, the non-resident investor

only misses out on the value of franking credits while they hold the stock, and this is a relatively minor cost.

However, the second argument is that global index funds are forced to invest a fixed amount into the Australian market. Thus, for every Australian share that is sold, another must be bought. That is, the index fund must continue to hold Australian stocks indefinitely and therefore misses out on the value of franking credits indefinitely. If the fund is required to maintain a permanent position in the Australian market, they will never realise any value from franking credits. That is, the fund is required to pay the (assumed) capitalised value of franking credits when they buy the stock. If they hold the same stock indefinitely, they receive no benefit at all from those franking credits that they paid for. If they trade out of one Australian stock into another, they are assumed to receive the capitalised value of credits from the stock that is sold, but then they must again pay the capitalised value of the credits in the stock that is bought. This is a wash and is therefore irrelevant. The net position is that if the fund takes an indefinite position in the Australian market, they will never realise any value from franking credits – therefore it makes little sense that they would be willing to pay for these credits when initially buying the shares.

1.9 Officer's real estate analogy is incomplete and inconsistent

Finally, Officer (2006) uses a real estate analogy to illustrate the third argument. The illustration is that of a couple with no children buying a four-bedroom house. They will have to pay more for a large house even though they get no benefit from the extra rooms. But when they later sell the house, the sale price will reflect the value of the additional room. Thus, it is argued, the cost of the additional rooms (that were of no value to the couple) was ultimately recouped. In this analogy, the couple represents non-resident investors and the additional rooms represent franking credits. Clearly, the couple plan to remain childless (non-residents). Also, the couple get absolutely zero benefit from having the additional rooms.

This analogy can be extended to provide additional insight. First, suppose that the couple planned to stay in the house forever. In this case, they pay for the additional rooms and never realise any benefit from them whatsoever. This would make no sense and the couple would instead buy a smaller house that is cheaper and provides them with all the same benefits (i.e., non-resident investors would not invest in Australia because they are being asked to pay for something they cannot use).

Next, suppose that the couple plan to buy a four-bedroom house, stay there for a while then move to another four-bedroom house, and so on. This is effectively the same as the previous scenario. When they sell the first house, they receive some value from the extra bedrooms. But then they have to pay this straight back when they buy the new house. It is a wash and therefore irrelevant. This plan also makes no sense – the couple would simply buy a smaller house to avoid the initial payment for additional bedrooms that they cannot use.

Now suppose that the couple plan to buy a four-bedroom house, stay there for a while, and then move to a smaller house. Here they pay for bedrooms that they cannot use, but then realise this value when they sell. There has been a cost to this – they could have invested the additional money and received some return on it, they have been paying additional rates, and so on. But the cost is limited to the time they spent in the four-bedroom house. This seems to be the situation that Officer (2006) has in mind. But this implies that the only form of foreign investment into Australia comes from investors who buy Australian shares, soon figure out that it was a bad idea because the returns are insufficient, and then sell never to return to this market. This does not represent a stable equilibrium and is inconsistent with the view that much of these funds are provided by long-term institutional investors.

The analogy can also be extended to include the notions of (a) Australia being a net importer of capital; and (b) non-resident investors having many options to invest in places other than Australia. Suppose a developer is highly leveraged and needs to sell all 500 houses in a development within the next month to repay the lenders. All 500 houses have four bedrooms, and there is a rule that all 500 must sell at the same price (i.e., there must be one stock price – we can't have one class of shares for residents and another for non-residents). But there are only 300 families in the market (i.e., not all shares can be sold to resident investors – there is a need to import foreign capital). So the other 200 houses must be sold to couples with no children. But the couples could live anywhere and there is an abundance of one-bedroom places all around the city. The couples will not pay more than the going price for one-bedroom places, so to sell all the houses, the value of the extra bedrooms will not be priced, even though this is of value to some of the buyers. This relates to the case of a small open market that is a net importer of capital, which Australia clearly is.

1.10 Conclusion

In the framework developed by Officer (1994), the effect of franking credits on the corporate cost of capital is quantified in the parameter gamma. If gamma takes a value greater than zero, this implies that the firm is able to pay dividends and capital gains to its shareholders at a rate less than what the market considers to be a fair return. The reason is that franking credits, provided by government, top up the return to a fair level. However, non-resident investors cannot use these franking credits and receive their return from dividends and capital gains only. Officer (2006) states that since 1987 almost \$100 billion of franking credits have been paid to shareholders who have not used them.

Consequently, setting gamma above zero implies that investors who cannot use franking credits will receive a lower than fair return. This is not a question of estimation or interpretation or supposition, it is a direct unambiguous mathematical consequence of Officer (1994). Therefore, setting gamma above zero requires an explanation of why non-resident investors would commit capital to the Australian market if they expected lower than fair returns. This section essentially examines three such reasons proposed in Officer (2006). I have examined each of these arguments and demonstrated the inconsistencies between them and shown that they imply economically implausible consequences.

However, my conclusion is that the impact of franking credits on the corporate cost of capital should not be determined by reference to various conceptual arguments but rather by reference to empirical data. It is not possible to determine an appropriate value for gamma by reference to conceptual arguments alone. Rather, empirical evidence should be examined first, and the conclusions from this analysis tested against conceptual reasoning. This is the approach adopted in Gray (2005), where I argue that the proper interpretation of the empirical evidence is that gamma should be set to zero, and then I explain conceptually that this result is the only one that is consistent with foreign investment in Australia earning a fair return.

2. Franking credits must be created and distributed if they are to have value

2.1 Franking credits are created by the payment of Australian corporate tax

I agree with Officer (2006, p.17) that “The appropriate gamma of FOXTEL would be the product of the proportion of future taxable profits that they were planning to payout and the value of each associated

credit.” Thus, even if credits were valued by investors once distributed, gamma would only take a positive value to the extent that FOXTEL *created* and *distributed* franking credits. Credits are created by the payment of Australian corporate tax and distributed via the payment of dividends or some other mechanism to return capital to shareholders such as a buyback.²

Therefore, in any year in which FOXTEL pays no corporate tax, it creates no franking credits and therefore shareholders receive no benefit from franking credits in that year. Of course it would be unreasonable to forecast that FOXTEL would *never* make any profit and never make any distribution to shareholders. If this were the case, the business should be shut down immediately. Therefore the situation is one in which a company makes no profit and pays no dividends for a period, but ultimately becomes profitable and begins to make distributions to shareholders. Even if all shareholders value franking credits, they gain no value from them in the initial period because none have been created.

2.2 Regulatory parameters are set at their present values, not expected future values

The question is whether, in a regulatory determination, we should estimate the value of credits during the regulatory period or a long-run perpetuity value. If, for example, no credits were created during the regulatory period, should we set gamma to zero or should we use a long-run perpetuity value? Officer (2006, pp.17-18.) addresses this issue by recognising that “It may very well be that FOXTEL will not make any profits in the next five years” but that “as the model is a perpetuity model the WACC past the next five years is quite relevant and so a gamma estimate is needed.” That is, Officer proposes that a long-term perpetuity value of franking credits should be used for regulatory purposes even if no franking credits will be generated during the regulatory cycle.

Moreover, even if FOXTEL does generate some profits over the regulatory period, I have been asked to assume that FOXTEL's cumulative profit is expected to be less than its accumulated losses for the majority of the regulatory period. Consequently, considering FOXTEL as a stand-alone entity (as is done when estimating WACC), FOXTEL is not expected to pay any Australian corporate tax and is therefore not expected to generate any franking credits over the regulatory period.

The necessary implication of this is that shareholders *cannot* earn the required return during the regulatory period. The illustration above shows that if all shareholders require a 14% return and they value franking credits such that gamma is 0.5, then 2.5% of their return will come from franking credits and the remaining 11.5% return must be provided by the firm. Suppose that all shareholders really do value franking credits in this way. These shareholders receive a return of 11.5% from dividends and capital gains and a further 2.5% return from franking credits, giving them the required 14% return. And suppose that regulated prices are set on this basis – allowing the firm to generate dividends and capital gains sufficient to produce a return of 11.5%.

But now suppose that the firm generates no franking credits during a particular regulatory period. Over this period the shareholders will earn an expected return of only 11.5%. That is, the firm's regulated cash flows are insufficient to provide an adequate return to shareholders over the regulatory period. When regulating returns for the current regulatory period, we should use parameter values that apply to the current regulatory period – not parameter values that will apply to future regulatory periods on average.

² I examine share buybacks in the following section.

Of course, this is exactly what is typically done in relation to other WACC parameters. Consider the risk-free rate or debt premium, for example. Both are currently at historical lows and are likely to be higher, on average, in the future. But there is no suggestion that we should take expected long-term averages for these parameters. Rather, the (correct) practice is to take present parameter estimates that reflect the cost of raising capital in the current circumstances.

2.3 It is incorrect to suggest that setting gamma to zero implies that the firm never pays franked dividends

Finally, Officer (2006, p.17) states that “FOXTEL could easily issue fewer credits than the average listed Australian company but it is not logical to consequently ascribe a zero value for gamma for FOXTEL. This would assume that they would never in any circumstances pay out a franked dividend from their FAB [franking account balance].” *This statement is clearly not correct.* Setting gamma to zero does *not* assume that the company never pays franked dividends at all.

Gamma should be set to zero if the relevant investor does not value the credits they receive. That is, credits can be generated and distributed and used by some investors, but if they are not valued by the relevant investor whose trading clears the market, they do not affect the corporate cost of capital and it would be appropriate to set gamma to zero.

2.4 Conclusions

If regulated prices are set on the basis of an assumed positive value for gamma, even though no franking credits will be distributed during the regulatory period, it is impossible for shareholders to earn a fair expected return.

Such a price-setting arrangement assumes that prices (and returns to shareholders) can be lower because shareholders can make up the shortfall by way of receiving (assumed) valuable franking credits. If no franking credits will be paid, the shortfall cannot be made up and shareholders will receive a lower than fair expected return.

3. Share buybacks as a way of distributing franking credits

3.1 Share buybacks can be used to distribute franking credits

Officer (2006) notes that franking credits can be distributed via share buybacks as well as dividends. He concludes (p.23) that “Many Australian companies pay a lot of attention to managing their capital by way of franking credits.” The argument is that Australian companies go to a lot of trouble and expense to construct share buyback arrangements to funnel substantial amounts of franking credits to a particular class of investors who value them. The implication is that firms would not do this unless they believed those investors valued franking credits. I agree – there is a class of investors who value franking credits. But, as explained above, this tells us nothing about the effect of franking credits on the corporate cost of capital.

In particular, Officer (2006, Section F.2) states that:

“There are more ways of distributing franking credits than just paying out franked credits with ordinary dividends. In this section, I will describe some recent buy-backs of their stocks that have involved very large amounts of franking credits. This mechanism has introduced a process of self-selection. Those investors who most value the credits can efficiently access them by selling their shares in the buy-back whereas those on higher marginal tax rates who prefer their returns through capital gains will not take up the buy-back offer. Effectively, this is a means by which the company can stream their dividends to maximize their value where they cannot directly pay separate dividend streams to different (with respect to tax) of shareholders...In my opinion, such major Australian listed companies would not be undertaking large buy-backs in these forms if they did not consider that a sufficient proportion of their shareholders placed substantial value on the associated franking credits.”

I agree with all of this. Moreover, I believe that this provides compelling evidence that Australian companies do not believe that franking credits reduce their cost of capital. Also, I note that this would be consistent with the dominant corporate practice of ignoring franking credits when estimating cost of capital.

3.2 Share buybacks can be used as a mechanism to stream franking credits

Suppose firms knew that franking credits were not reflected in the price of their ordinary shares, and did not reduce their cost of capital. This is exactly equivalent to saying that the marginal price-setting investor (whoever that may be) does not value franking credits. This implies that when a firm distributes franking credits (via dividends) to its entire shareholder base, it receives no benefit – these franking credits are not valued by the relevant shareholder. In this setting, firms know that (1) some of their shareholders value franking credits and others do not; and (2) if franking credits are distributed generally to all shareholders, the firm receives no benefit – the stock price does not increase and the cost of capital is not reduced because these credits are not valued by the price-setting investor.

In these circumstances, we would expect the firm to create some mechanism for channelling franking credits to those shareholders who can use them. In the first years after imputation, many Australian firms engaged in dividend streaming – they would pay franked dividends to residents and unfranked dividends to non-residents. Changes to Australian tax laws effectively eliminated this practice. However, share buybacks have recently proven to be somewhat of a substitute for this practice.

3.3 The impact of share buybacks is relatively small

A common structure is for a firm to offer to buy back shares at a substantial discount to the current market price. The compensation is paid by way of a small capital amount and a large fully-franked dividend. For example, Officer (2006) reports that Telstra shares were bought back for \$1.50 capital plus \$2.55 cash dividends (total \$4.05) at a time when the stock price was around \$5.00. This is because a \$1.09 franking credit was attached to the dividend. Those shareholders who can use the franking credit may therefore value the package at more than the current stock price and agree to participate.³ This allows the company to exchange \$4.05 cash for one of its shares that are trading at \$5.00. Therefore, this is a way of extracting some value from franking credits. It is likely that a company would only go to this trouble and expense

³ The capital gains tax position and marginal tax rate of the specific investor will also be relevant to the decision of whether or not to participate. The buyback is more attractive to low-tax shareholders.

if they believed they could not extract this value from franking credits by simply attaching them to regular dividends.

Note that in this mechanism, all shareholders benefit from the way the firm has extracted value from the franking credits via the buyback. Suppose a firm buys back 5% of its shares under the terms described above. That is, the firm has 20 shares trading at \$5.00 each and buys one back for (say) \$4.00 cash, plus some franking credits. The value of the firm will fall by \$4.00 since this is the amount of cash that is paid out. The remaining \$96 will be split among 19 shares, giving a share price of \$5.05. So all shareholders benefit from the way the firm has extracted some value from its franking credits at last.

Whereas this effect is worthwhile, it is relatively small. A buyback of 5% of equity capital in one transaction would be significant. For a particular firm, such transactions are likely to occur once every few years at most. Even then, under the terms of the example above, shareholders received only a 1% return in that the effect of the buyback was to increase the stock price by 5 cents. Thus, the impact on a firm's cost of equity capital and ultimately its WACC is likely to be small.

3.3 Conclusions

So why do firm's engage in buybacks if their impact is economically small? First, as well as a means of channelling franking credits, a buyback is a way of returning capital to shareholders in circumstances when a firm has excess capital relative to its capital expenditure requirements. That is, the main purpose is not to channel franking credits but to return excess capital to shareholders. Second, even though the impact on the cost of capital is small, it is preferable to simply paying a larger dividend to *all* shareholders in which case the firm obtains zero value from franking credits.

4. Evidence from Broker Valuations

4.1 Independent valuation experts and Australian firms themselves set gamma to zero

Gray (2005) provides evidence that (1) the dominant practice of Australian firms is to ignore franking credits when estimating their cost of capital and when evaluating new projects; and (2) the dominant practice of independent valuation experts is to ignore franking credits when providing independent expert valuation advice as part of takeover or other formal proceedings.

4.2 Some brokers provide valuations with and without franking credits, recognizing that some clients value franking credits and others do not

Officer (2006) introduces some evidence from stock broker valuations. This evidence indicates that some Australian brokers ignore franking credits in their research reports and when forming a target price for a stock. Others report valuations with and without ascribing some value to franking credits.

Therefore, the question is whether broker research or independent expert valuations or the practice of Australian firms themselves is most relevant to estimating the effect of franking credits on the cost of capital of Australian firms.

In my view, broker research is of little relevance to the issue at hand for the following reasons:

1. Brokers tend to provide valuations with and without the value of franking credits. The sample valuation provided by Officer (2006), for example, values Patrick Corporation at \$5.71 ignoring franking credits and at \$6.51 including franking credits. *If I were writing a broker research report for Australian and international clients this is exactly what I would do.* It is certainly the case that some clients can use franking credits and would be interested in a discounted cash flow valuation that includes them. This is because they will indeed receive future cash flows from franking credits. Equally, other clients cannot use franking credits and would not want to discount future cash flows that include franking credits that they cannot use. Consequently, it make perfect sense to provide valuations with, and without, franking credits. Indeed, I am aware that Credit Suisse has recently introduced a policy of doing exactly this in order that individual clients can decide which of the two valuations is relevant for them. But this says nothing about the effect of franking credits on the corporate cost of capital. All this says is that the practice of Australian brokers confirms that some investors value franking credits and others do not. Whether franking credits affect the cost of capital depends on whether the marginal price-setting investor whose trade clears the market values franking credits or not. As described above, many conceptual arguments can be made about this, but it is ultimately an empirical question.
2. The accounting and finance literature has demonstrated a number of biases in broker research. First, broker valuations are consistently optimistic. On average, forecast earnings, dividends, and target prices consistently exceed actual outcomes. Second, if stocks were fairly priced, on average, one would expect equal numbers of buy and sell recommendations. Yet the number of buy recommendations greatly exceeds the number of sell recommendations. The literature suggests that this is because the main purpose of broker research is to generate trading volume. Optimistic buy recommendations are potentially relevant to all clients, but sell recommendations have a much smaller audience – those who already hold the stock.
3. Conversely, independent valuation experts have an incentive to provide the most accurate report possible. Their future work is impaired by any systematic bias in valuations.
4. Moreover, the whole purpose of estimating the cost of capital is so it can be used to discount corporate cash flows. There is very clear evidence that when Australian firms themselves estimate their cost of capital, franking credits are ignored.

4.3 Conclusions

In my view, the evidence from broker research simply suggests that brokers believe that some of their clients value franking credits and others do not. But we already knew this to be the case. The question of whether franking credits affect the corporate cost of capital is quite different. That will depend on equilibrium considerations and is ultimately an empirical question.

5. Statistical Issues in Dividend Drop-off Studies

5.1 Multi-collinearity is a potential problem, affecting our ability to interpret the empirical results

Officer (2006) argues that Gray (2005) mis-represents a statistical issue in the empirical analysis of Hathaway and Officer (2004, p.20.):

“Prof Gray has a criticism of our valuation method which is quite erroneous. He criticises a model we do not use in the form he asserts.”

Gray (2005) discusses a model in which stock price changes around ex-dividend dates are regressed on the size of the dividend and the franking credit. This empirical model, using the notation of Officer (2006) is:

$$\Delta P = \alpha D + \beta fcD + error.$$

In this model, ΔP represents the change in stock price on the ex-dividend day, D is the amount of cash dividends and fc is the extent to which the dividend is franked (between 0 and 100%). The regression parameters, α and β , are interpreted as signalling the value of cash dividends and franking credits, respectively.

The problem with this regression model is one of multi-collinearity among the two right-hand side variables. To see this, suppose that all dividends are fully franked, so fc takes the value 1.00 for all observations. In this case, price changes are being regressed on two right-hand-side variables, both of which are the same. In this extreme case of multi-collinearity, the model is statistically mis-specified to the extent that statistical software will be unable to compute any estimate of the regression parameters. In the actual data set examined by Hathaway and Officer (2004) not all dividends are fully franked, but the great majority are. This creates a case of severe, but not perfect, multi-collinearity. The result is that statistical software is able to generate parameter estimates, but these are statistically unreliable. Multi-collinearity often manifests itself as wildly different parameter estimates being produced in different subsets of the data when there is no economically plausible reason for such differences.

Officer (2006, p.20.) agrees that multi-collinearity is a problem in this model. He notes that Gray (2005):

“rightly points out that this model has a statistical problem in that the dividend amount, D , is in two places on the right hand side of the model so both terms cannot be statistically identified because they are highly correlated.”

5.2 Scaling the data does not remove multi-collinearity

Officer (2006, p.20.) goes on to argue that this is not the regression model in Hathaway and Officer (2004). Rather, they scale all variables by the amount of the dividend:

“The model we estimate has the dividend divided through so that the dependent variable is not the amount of dollar price drop but rather the fractional drop-off of price relative to the dividend amount.”

This model is:

$$\frac{\Delta P}{D} = \alpha + \beta fc + error.$$

However, just as in the previous case, if all dividends are fully franked the two right-hand side variables are identical. That is, if you have two identical variables and you divide both by the same amount they remain

identical. As noted above, in the actual data set examined by Hathaway and Officer (2004) not all dividends are fully franked, but the great majority are. Therefore, the right-hand side variables are substantially the same and multi-collinearity remains a potential problem. In particular, if multi-collinearity is a problem in the original model, it is no less a problem in the scaled model.

5.3 The effect of multi-collinearity is an empirical question – do different sub-sets of the data produce inconsistent results?

All of the discussion so far is at a conceptual level and the effect of this potential statistical problem is ultimately an empirical question. If different sub-samples of the data contain wildly different parameter estimates with no economically plausible reason, this is an indication that multi-collinearity is causing problems and that the parameter estimates are unreliable.

In the revised version of Hathaway and Officer (2004), the authors provide estimates of the value of franking credits for sub-samples of small, medium, and large firms and separately for high-yield firms. The results are reported in four panels in Table 3 corresponding to various versions of the basic model described above. When all data points are included in the sample, the value of franking credits ranges from -4% to 27% and the value of cash dividends ranges from 56% to 83%. When the data is split into sub-samples based on firm size, the value of franking credits ranges between -11% to 89%. In some sub-samples, franking credits are reported as being more valuable than cash dividends and in other sub-samples they are reported as being worthless. If there is any general trend it is that franking credits are worth much less in small firms than in large firms. This certainly runs counter to any argument that the value of franking credits is based on the average (rather than marginal) investor in the firm as small firms are held almost exclusively by resident investors, who can all use franking credits. That is, non-resident investors (who cannot use franking credits) cluster strongly in large firms, yet the results suggest that this is where franking credits are most valuable.

It is difficult to envisage any economically plausible reasoning that explains this kind of variation in the results for different sub-samples. But there is an alternative *statistical* explanation – this is exactly the type of result that would be expected if multi-collinearity were an issue.

5.4 If multi-collinearity is to be ignored, we should at least use the results that are relevant for FOXTEL

Hathaway and Officer (2004) report estimates for the value of dividends and franking credits for companies of various sizes. The estimates that they focus on in their conclusions relate only to the top 50 listed Australian companies by market capitalization. As a separate entity, FOXTEL would not be a top-50 company. The more relevant results would come from companies that are more comparable to FOXTEL.

Hathaway and Officer (2004) report that for companies outside the top 100, franking credits are valued between -10 cents and 12 cents per dollar. None of their results suggest that for these companies franking credits are valued anywhere near 50 cents per dollar.

Of course, I have argued above that the likely reason for the great differences between estimates for different sub-samples is multi-collinearity. But if that argument is rejected and the Hathaway-Officer results are to be interpreted at face value, we should use the relevant estimates – those that come from analysing companies most similar to FOXTEL.

5.5 If multi-collinearity is to be ignored, we should at least ensure consistency between the empirical estimates and the model in which they are to be used

Another issue that arises is that of the consistency between the way gamma is estimated and the model in which it is to be used. The model that has become known in Australian regulatory circles as the Officer-CAPM⁴ is based on a number of important assumptions. One of these assumptions is that dividends and capital gains are valued equally by investors. There are variations of the model that allow for dividends and capital gains to be valued differently. Brennan (1977) constructs such a model for a classical tax system and Lally (1996), Lally and Van Zijl (2003) and Monkhouse (1993) have models extending this to an imputation system.

The finance literature in the 1980s debated the relative merits of the standard CAPM and a more complex model that allows for dividends and capital gains to be valued differently. A number of theoretical and empirical arguments were made, but the practical outcome is that the standard CAPM clearly reigns as the industry standard. However, if one firmly believed that dividends and capital gains are valued differently, there are models to accommodate this in both the classical and imputation tax systems.

The Australian regulatory system uses the standard CAPM to estimate the required return on equity and therefore is based on the assumption that dividends and capital gains are equally valued.

Hathaway and Officer (2004) use a regression model to separately estimate the value of cash dividends and franking credits. They obtain a wide range of results depending on the type of firm, data set, and empirical specification. Of the 12 sets of results reported in their Table 3, they favour the three that suggest that franking credits are worth around 50% of face value when distributed.⁵ However, the same analysis that suggests that franking credits are worth 50% of face value also suggests that cash dividends are worth 80% of capital gains. It would be inconsistent and wrong to use this estimate of the value of franking credits in a model that assumes dividends and capital gains are equally valued.⁶ This is analogous to selecting a rugby team after watching how well the players play soccer.

The intuition for this is as follows. The Hathaway-Officer result suggests that dividends are worth only 80% of capital gains. This implies that shareholders would be indifferent between receiving a \$1 dividend and an 80 cent capital gain. Therefore, firms that pay higher dividends would have to pay higher returns – the shareholders would require higher returns because they come in the form of dividends, which are less valuable.⁷ But there is a potential benefit to higher dividends – a higher dividend means that more franking credits can be distributed. According to Hathaway and Officer (2004), these franking credits are valuable to the relevant investor. Thus, the corporate cost of equity capital is the shareholder's required return adjusted for the value of franking credits. If a firm pays high dividends, the Hathaway-Officer results suggest that the required return is higher, but that there is also a larger downward adjustment due to the value of franking credits. According to the Hathaway-Officer results, these two effects act to offset one another.

⁴ Officer (1994).

⁵ They then suggest that this should be multiplied by the average distribution rate of 70% to obtain an estimate for gamma of around 0.35.

⁶ Hathaway and Officer (2004) do not suggest that this should be done – they simply provide estimates of the value of franking credits and cash dividends.

⁷ As noted above, there are models to accommodate this.

However, if the estimated value of franking credits is used in the standard CAPM, only one of the two offsetting effects is being considered. This is internally inconsistent and wrong. There are two ways forward:

1. If the Hathaway-Officer results are to be used, we must use the full result and not half of it. This would require using a model that allows dividends and capital gains to be valued differently.
2. If the standard CAPM is to be retained, we should impose the assumption that dividends and capital gains are equally valued on the estimation. That is, we should estimate the value of franking credits after restricting the value of cash dividends. Bellamy and Gray (2004) have performed exactly this exercise using a data set and methodology substantially the same as in Hathaway-Officer. They report in their Table 8 that when dividends are restricted to have the same value as capital gains, the estimate of the value of franking credits is zero. That is, if we are to estimate the value of franking credits in a way that is consistent with the standard CAPM, the relevant value is zero. Moreover, Bellamy and Gray also show that this restricted estimation fits the data just as well as the unconstrained estimation. That is, the data are equally consistent with the results of Hathaway and Officer (2004) and a model in which dividends are fully valued and franking credits are not valued at all by the relevant investor. Both models fit the data equally as well, but only one is consistent with the Officer-CAPM approach to WACC.

5.6 Conclusions

It is generally recognised and agreed that multi-collinearity is a potential problem when regressing stock price changes on dividends and franking credits. Officer argues that scaling the data by the amount of the dividend eliminates the problem of multi-collinearity. As a general statistical principle, I do not believe that scaling data eliminates multi-collinearity. Moreover, the parameter estimates vary considerably across different data sets and there is no economically plausible reason for this. This is exactly what would be expected if multi-collinearity were present.

If, however, the results are to be taken at face value, one should use the results from firms similar to FOXTEL. For firms outside the top 100, Hathaway and Officer find little evidence that franking credits are valued by the relevant investor at all.

Finally, we should also use results that are consistent with the model they are to be used in. The standard CAPM assumes that dividends and franking credits are equally valued. Consequently, we should impose this restriction before estimating the value of franking credits. Bellamy and Gray (2004) show that when this is done, the results imply that franking credits are not valued by the relevant investor. Moreover, this restricted model fits the data as well as any unrestricted model estimated by Hathaway and Officer.

Results from dividend drop-off studies cannot be used to justify setting gamma above zero.

6. Criticism of Cannavan, Finn, and Gray (2004)

6.1 A test of model mis-specification

Officer (2006) argues that the results in Cannavan, Finn, and Gray (2004) may be affected by model mis-specification error. Whereas the authors claim to solve for the implied value of dividends and franking

credits, Officer argues that they may be solving for the value of these plus the effects of model mis-specification. That is, the authors use the standard and well-accepted cost of carry framework to value futures contracts. This models the futures price as a function of the stock price, dividends, and franking credits. By comparing the futures price with the stock price, the authors seek to solve for the implied value of dividends and franking credits. But Officer argues that to the extent the cost of carry framework is incorrect, any model mis-specification error will contaminate the estimates of the value of dividends and franking credits.

But Cannavan, Finn, and Gray (2004) rule out this possibility via an analysis of observations that do *not* involve dividends. They show that the relationship between futures and stock prices behaves *exactly* as predicted by the model for observations in which no dividend is involved. This implies that there is no model mis-specification error, so any effect that is attributed to dividends and capital gains is really caused by them and not by model mis-specification error.

Cannavan, Finn, and Gray (2004, pp. 184-5) spell this out quite clearly in their paper:

“We begin by testing the accuracy of our cost-of-carry no-arbitrage valuation formula in the absence of dividends. To do this, we collect every trade of ISF and LEPO contracts in our sample for which there is no dividend prior to maturity of the contract...The mean value of the relative pricing error is around 0.01%. This is economically insignificant given transactions costs on stocks are at least 0.3% of the stock price. Even if transactions costs were zero, the magnitude of any arbitrage opportunity is very small. The mispricing on a \$25 stock, for example, amounts to a quarter of a cent per share. Therefore, on average, the pricing of ISF and LEPO contracts with no intervening dividend payment to maturity is consistent with the no-arbitrage pricing relationship.”

6.2 Conclusion

A comprehensive check for model mis-specification was performed by the authors. This has demonstrated, to the satisfaction of the editors and referees of one of the leading finance journals, that model mis-specification error has not contaminated the results.

7. Other matters requiring explanation

7.1 What is the appropriate value for gamma?

Having proposed a value for gamma, one should examine its economic reasonableness by computing the rate at which franking credits must be distributed to shareholders. That is, there is a mathematical relationship between the assumed value of gamma and the rate at which franking credits must be created and distributed. If the assumed value of gamma implies a rate of creation or distribution that is economically implausible, that value of gamma must be changed. However, nowhere in Officer (2006) is an appropriate estimate of gamma proposed. Moreover, this question was never even referred for comment.

For this reason, I summarise the approach described in Gray (2005) for checking the economic reasonableness of the assumed value of gamma. This approach simply determines the rate at which franking credits must be created and distributed to shareholders to support the assumed value of gamma.

7.2 The relationship between gamma and dividend yield

Section 1.3 above demonstrates how the assumed value of gamma implies the proportions of the shareholders' return that comes from dividends and capital gains and the proportion that comes from franking credits. The parameters used in the ACCC's 2003 Report imply that FOXTEL's shareholders require a total return of 15.5% p.a. and that 12.7% p.a. must come from dividends and capital gains and the remaining 2.8% p.a. is from franking credits. This return from franking credits is an immediate consequence of the assumption that gamma is equal to 0.5.

This value of gamma was consistent with Australian regulatory precedent in 2003 which often involved breaking the estimate into its two component pieces – assuming that around 80% of the franking credits that are created by the firm are distributed to shareholders and that the distributed franking are valued by shareholders at 60% of their face value.

If franking credits generate a return of 2.8%, and if distributed franking credits are valued at 60% of their face value, the amount of franking credits distributed must be $2.8\%/0.6 = 4.7\%$ of the value of the shares. That is, if the share price is \$10, the firm must distribute 47 cents of franking credits each year, which would then be worth 28 cents (60%) to shareholders.

Of course, franking credits must be attached to dividends and the maximum amount of franking credits that can be attached to each dollar of dividends is $\$T/(1-T)$, where T represents the corporate tax rate that applied at the time the franking credits were created.⁸ At the 30% corporate tax rate assumed in the ACCC's 2003 Report, 43 cents of franking credits can be attached to each dollar of dividends. Thus, if 47 cents of franking credits are to be distributed, they must be attached to \$1.09 of dividends. This implies that a dividend yield of 10.9% p.a. is required in order to generate the 2.8% p.a. return from franking credits that is assumed in the ACCC's 2003 Report.

A 10.9% dividend yield is around three times the dividend yield of the average Australian stock (3.5-4.0%). Moreover, FOXTEL itself has never made a dividend payment to its shareholders and has not indicated that it has any plans to make any such payment in the foreseeable future.

Finally, it cannot be argued that FOXTEL could instead distribute these franking credits via share buybacks. First, it is fanciful that a firm that has substantial accumulated losses and has never recorded a profit would even consider a buyback. Buybacks are a mechanism for returning surplus capital to shareholders – few would consider FOXTEL to have surplus capital.

Moreover, even in the extreme case of FOXTEL buying back 5% of its equity *every year* the required return from franking credits could not be generated. It would require FOXTEL to be able to buy back its own shares at a discount of 53% to market prices to achieve a franking credit return of 2.8%.

It is simply not possible for FOXTEL to distribute franking credits sufficient to justify setting gamma to 0.5.

⁸ See Paragraph 1.5 above.

7.3 Updated results

Much of Officer (2006) and the response in this report concerns the propriety of using the techniques of Hathaway and Officer (2004) to estimate the value of franking credits. I have argued in Gray (2005) and in this report that:

- The dividend drop-off technique is affected by multi-collinearity, even with data scaled by dividends; and
- The Hathaway-Officer results for the value of franking credits are conditional on dividends being substantially less valuable than capital gains, yet these results will be used in a model that assumes dividends and capital gains to be equally valued. This inconsistency can be corrected by either using a model that allows for dividends and capital gains to be valued differently, or by estimating the value of franking credits after constraining dividends and capital gains to be equally valued – consistent with the model in which the estimates are to be used.

Therefore, the appropriate value for gamma depends on one's view of these arguments as follows:

1. If one forms the view that the techniques of Hathaway-Officer are contaminated by statistical problems, their results should not be relied upon. Cannavan, Finn, and Gray (2004), in a top-tier publication, conclude that an appropriate value of gamma is zero.
2. If one requires consistency between the model for which the estimate of gamma is to be used and the way gamma is estimated, then gamma must be estimated after constraining dividends and capital gains to be equally valued. Bellamy and Gray (2004) show, using the same methodology and data source as Hathaway-Officer, that this produces a gamma estimate of zero.
3. If one is prepared to accommodate potential statistical problems and a demonstrable inconsistency between the way gamma is estimated and the model in which it is to be used, then one should accept the results of Hathaway-Officer. In the latest version of their paper, they recommend an estimate of 0.35. Based on a revised data set, Hathaway and Officer have revised their estimate from 0.5 to 0.35. To the extent that Australian regulatory precedent was based on the results from the earlier version (no other paper in this area produces an estimate close to 0.5), retaining the former estimate of 0.5 in the face of the latest evidence would seem incongruous.

Consequently, the possible range for estimates of gamma would have a lower bound of zero, based on the estimates of Cannavan, Finn, and Gray (2004) and Bellamy and Gray (2004) and consistent with the conceptual equilibrium arguments in this report.

The upper bound would be 0.35, and would only be justified in the case where it could be shown that the Hathaway-Officer results are not contaminated by statistical problems and where consistency between the model and the estimation technique were not required.

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Signature

A handwritten signature in blue ink that reads "Stephen Gray". The signature is written in a cursive style with a large, looped 'G' at the end.

28 March, 2006

Prof. Stephen Gray