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Market Arbitrage of Cash Dividends and Franking Credits*

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Since 1986, dividend imputation has influenced the ex-dividend day behaviour of Australian share prices. This paper explores the effects of dividend imputation on ex-dividend share price drop-off from its inception until mid-2004, with particular attention paid to the differential effects of cash dividends and franking credits. We also explore the effects of the six major legislative amendments to the dividend imputation system that were introduced over the sample period. Only the most recent tax change, which provided full income rebates for unused franking credits, appears to have caused the market to put a statistically significant value on franking credits.

I Introduction

The theory of arbitrage predicts that in perfect capital markets, with no transactions costs and no dividend imputation, the expected reduction in the price of a share on its ex-dividend day should equal the amount of the cash dividend. Under dividend imputation, shareholders receive a gross dividend, which is the cash dividend plus a franking credit, where the franking credit has the value of tax already paid on that income at the company level. It follows that in perfect capital markets with no transactions costs, the expected ex-dividend day share price drop-off should equal the size of the gross dividend. However, many studies have observed a price drop less than the size of the gross dividend (e.g. Eades *et al*., 1984; Lakonishok & Vermaelen, 1986; Karpoff & Walking, 1988) and a variety of different theories have been proposed to explain this inefficient pricing (e.g. Heath & Jarrow, 1988; Michaely & Vila, 1996).

Australia has been operating under a dividend imputation system since 1986. In this context it has been suggested that inefficient pricing may be due to franking credits being undervalued (e.g. Lakonishok & Vermaelen (1983) or Brown & Clarke (1993) in an Australian context) which, perhaps, was the motivation behind the implementation of six substantial tax regime changes between 1 April 1986 and 30 May 2004.

This paper considers the impact of cash dividends and franking credits on ex-dividend share price adjustments for companies and trusts whose primary listing is on the Australian Stock Exchange. We examine whether share prices adjust efficiently to reflect the full after-tax value of the gross dividend and discuss reasons why efficient pricing may not emerge, with a particular focus on the differential effects of cash dividends and franking credits. We also examine the impact of the various tax regime changes on the valuation of franking credits.

The remainder of this paper is structured as follows. Section II introduces the basic model and

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surveys the relevant literature on dividend drop-off effects. Section III provides the empirical specifications that we use to estimate dividend drop-off effects and develops various hypotheses that we subsequently explore. Results are presented in Section IV, while Section V concludes. The above-mentioned tax regime changes are discussed in Appendix I and a complete description of our dataset is provided in Appendix II.

II Theoretical Foundations

Our basic model builds on the seminal paper of Elton and Gruber (1970) and, like them, we shall assume that there is no stochastic uncertainty, that the costs of delaying or accelerating transactions (foregone interest) are ignored, and that transactions costs are zero. Under dividend imputation the natural focus of attention is the gross dividend, being the sum of the cash dividend and a franking credit. The franking credit, F, is

$$F = D\left(\frac{sT_c}{1 - T_c}\right)$$

where D denotes the cash dividend per share, s denotes the proportion of dividend upon which Australian tax has been paid, and T_c denotes the company tax rate. The gross dividend, G, is then

$$G = D + F = D\left[1 + \frac{sT_c}{1 - T_c}\right]$$

Economic efficiency requires that there is no opportunity to arbitrage between the cum-dividend and ex-dividend share prices, denoted P_c and P_x, respectively. Therefore, profit from selling a stock cum-dividend (π_c) must equal profit from selling the same stock ex-dividend (π_x).[1] Letting P_0 denote the price per share at which the share was purchased, T_d the tax rate on ordinary income (including dividends), and T_g the tax rate on capital gains, we see that

$$\pi_c = P_c - T_g(P_c - P_0)$$

and

$$\pi_x = P_x + D(1 - T_d)\left[1 + \frac{sT_c}{1 - T_c}\right] - T_g(P_x - P_0)$$

Therefore the no-arbitrage condition is

$$P_c - T_g(P_c - P_0) = P_x + D(1 - T_d)\left[1 + \frac{sT_c}{1 - T_c}\right] - T_g(P_x - P_0) \quad (1)$$

Rearranging this equation, we can define the gross drop-off ratio (*GDOR*) to be the price change at the ex-dividend date divided by the gross dividend:[2]

$$GDOR = \frac{P_c - P_x}{G} = \frac{1 - T_d}{1 - T_g} \quad (2)$$

There are two competing predictions from this model as to the expected behaviour of ex-dividend share price adjustments. The short-term trading hypothesis says that the ex-dividend event is dominated by short-term arbitrageurs whose short-term trading gains are taxed in the same way as dividend income. These arbitrageurs engage in trade around the ex-dividend day until the fall in the share price equals the size of the dividend (i.e. $T_d = T_g$ and $GDOR = 1$). Conversely, the long-term trading hypothesis says that the ex-dividend event is dominated by long-term traders whose dividend income is taxed more heavily than capital gains (i.e. $T_d > T_g$ and so $GDOR < 1$). For these traders, capital gains are valued more highly than dividends and consequently the ex-dividend price drop-off is less than the size of the dividend. The relative merits of these two predictions must be determined empirically. The rest of this section explores the existing literature.

Lakonishok and Vermaelen (1983) argued that dividend imputation systems increase the value of dividends relative to capital gains, which is specifically relevant to analysing the long-term trading hypothesis. They estimated Canadian drop-off ratios before and after Canada's 1971 imputation tax reform. Despite an increase in the value of dividends relative to capital gains, they observed a permanent decrease in drop-off ratios following the tax change, contradicting the predictions of the long-term trading hypothesis, although some have argued that this result can be explained by their treatment of small dividend payments (see, for example, Booth & Johnston, 1984). Poterba and Summers (1984) examined the behaviour of UK

[1] A similar analysis could be followed using the condition that the cost of buying the stock cum-dividend (share price less the dividend net of income tax) equals the cost of buying ex-dividend (share price plus the present value of additional capital gains payable). Under our assumptions the results will be identical.

[2] Equally, we can define a cash drop-off ratio (*CDOR*) as the ratio of the price change at the ex-dividend date to the cash dividend, namely

$$CDOR = \frac{P_c - P_x}{D} = \frac{1 - T_d}{1 - T_g}\left[1 + \frac{sT_c}{1 - T_c}\right]$$

drop-off ratios before and after the introduction of a partial imputation system in 1973. They noted a permanent increase in the drop-off ratio after the introduction of partial imputation, which was consistent with the long-term trading hypothesis.

Brown and Walter (1986) provided the first Australian study of the ex-dividend day behaviour of share prices.[3] Analysing dividend events from 1973 to 1985, they reported an average drop-off ratio of 0.75, which was significantly less than unity. Although their results were consistent with the long term-trading hypothesis, they were hesitant to attribute this drop-off ratio to a tax differential. Instead, they discussed the possible effect of institutional factors and transactions costs. Wood (1991) extended their findings, looking specifically at whether there was evidence to support the short-term trading hypothesis in Australian markets by examining the behaviour of arbitrageurs around the ex-dividend day, and concluded that arbitrage activity did not significantly affect the average drop-off ratios.

De Jager (1992) provided another early examination of the relationship between ex-dividend share price falls and dividend imputation in an Australian context. However, in contrast to this paper, he was not concerned with measuring the ex-dividend day share price drop-off. His primary concern was how both resident and non-resident arbitrageurs and portfolio managers should re-adjust their stock holdings in Australia given that the drop-off ratio was other than unity.

Brown and Clarke (1993) analysed the ex-dividend day behaviour of Australian share prices from 1973 to 1991. They estimated yearly average drop-off ratios on the ex-dividend day. To allow for the fact that some stocks are thinly traded and the market may not clear in a single day, they also estimated drop-off ratios over the period 4 days before the ex-dividend day to 4 days after the ex-dividend day. They observed drop-off ratios significantly less than one using both 1 day and 4 days either side of the ex-dividend event.

Brown and Clarke then examined the effect on drop-off ratios of the tax changes implemented during their sample period, with the most significant tax change being the implementation of a dividend imputation tax system in 1987. The dividend imputation system increased the value of dividends relative to capital gains, thus making dividends more attractive to investors. They predicted that this would lead to an increase in drop-off ratios but they found instead that drop-off ratios initially decreased after the introduction of the dividend imputation system, the same result observed by Lakonishok and Vermaelen (1983) in the Canadian data. They also observed a slight increase in drop-off ratios at the end of the sample, which led to the suggestion that the initial decrease was due to uncertainty about the value and effect of franking credits.

Several Australian studies have built upon Brown and Clarke (1993). Bellamy (1994) found that stocks paying franked dividends have significantly higher average cash drop-off ratios (0.89) than stocks paying unfranked dividends (0.66). This is consistent with the idea that shareholders were attributing at least some value to the embedded franking credits.[4] Walker and Partington (1999) estimated gross drop-off ratios using data on contemporaneous cum-dividend and ex-dividend trades. That is, they calculated gross drop-off ratios using a sample of stocks that traded both cum-dividend and ex-dividend on the ex-dividend day on the grounds that such a dataset would filter out noise caused by movements in the market and movements in individual stocks. They reported an average gross drop-off ratio of 1.23 for stocks paying fully franked dividends. Their estimates were significantly higher than those observed previously in the literature, but there is an argument that these estimates cannot be meaningfully compared to other studies. The market for cum-dividend shares traded on the ex-dividend day is usually very small, as evidenced by low trading volumes, and these markets are likely to be affected by specific clientele effects. In particular, the participants in these markets are typically stockbrokers, who are usually in the market only to facilitate clearing and settlement obligations with other brokers. Moreover, shares trading cum-dividend on the ex-dividend day are overwhelmingly high yield stocks, so the sample is not representative. Therefore, the estimates obtained using data from these markets may not be a useful reflection of relevant behaviour.

More recent literature has seen the tentative development of alternative hypotheses to explain why share prices fall less than the dividend amounts during the ex-dividend period. These new theories reject the long-term trading hypothesis and instead focus on market microstructure arguments.

[3] Note that Brown and Walter (1986) only consider cash dividends.

[4] For similar discussion, see Hathaway and Officer (1992).

Bali and Hite (1998) argued that drop-off ratios are affected by the discreteness of stock prices. They suggested that the rounding down of prices causes the share price to fall by less than the size of the dividend. Alternatively, Frank and Jangannathan (1998) argued that, because most traders are individual long-term traders and most transactions occur at the ask price cum-dividend and the bid price ex-dividend, the imbalance in transactions will cause the price to fall by less than the size of the dividend.

Despite the development of these microstructure arguments, subsequent studies have supported the long-term trading hypothesis. Green and Rydqvist (1999) estimated drop-off ratios using Swedish lottery bonds, observing average drop-off ratios less than 1. Similarly, Milonas *et al*. (2005) estimated drop-off ratios for taxable and non-taxable dividends in the Chinese stock market and reported results consistent with the long-term trading hypothesis. Elton *et al*. (2005) revisited the earlier work of Elton and Gruber (1970) using data on closed-end managed investment funds. They rejected the market microstructure arguments, and using their selective sample, concluded that the ex-dividend day drop-off was most consistent with the long-term trading hypothesis.

Bellamy and Gray (2004) considered the statistical issues of isolating the effect of the cash dividend and franking credit in the context of Australian data for the period 1995–2002. They focused on the high degree of multicolinearity in the data between the cash dividend and the franking credit. These two variables would be perfectly collinear except for instances of changes in corporate tax rates, instances where untaxed income is distributed (such as from listed property trusts), and instances of foreign-sourced company income that does not attract a tax credit for foreign paid taxes. They considered the effect of only one tax regime change, the 45-day change in 1997, and found that the gross drop-off ratio moved in the opposite direction to their prediction. This led them to conclude that cash dividends are fully valued and franking credits have zero value to the marginal investor.

In an important paper, Cannavan *et al*. (2004) inferred the value of cash dividends and dividend franking credits using derivative securities unique to the Australian market. They used individual share futures (ISF) contracts and low exercise price options (LEPO) to reduce the problems associated with noise in security prices and market microstructure effects. Using a sample from May 1994 to December 1999, they found that investors placed the same value on a dollar of cash dividends as a dollar of future profit, and that gross drop-off ratios were significantly less than unity. Furthermore, Cannavan *et al*. (2004) discussed the July 1997 tax change that was designed to restrict the trading of franking credits, and examined whether this change affected the value of franking credits. They found that the average value of franking credits was insignificantly different from zero for much of the sample, although they noted that the value of franking credits was larger for high yielding firms. They also concluded that the July 1997 tax change had the effect of reducing the value of franking credits to an economically small negative number.

III Empirical Specifications

In the long run we would expect the no-arbitrage condition (1) to hold, but the impact of new information coming into the market, coupled with arbitrageurs' inability to perfectly foresee this new information, means that for any dividend event it is only likely to hold with error. A useful representation of this situation is

$$P_{c,i} - P_{x,i} = \beta_0 + \beta_1 G_i + \varepsilon_i, \quad i = 1, \dots, n \qquad (3)$$

where i is an index of the dividend event, n is the number of sample observations, and the short- and long-term trading hypotheses correspond to $\beta_1 = 1$ and $\beta_1 < 1$, respectively, where β_1 is the *GDOR*.[5] Observe that the standard assumption in the dividend drop-off ratio literature is to treat the cum-dividend price $P_{c,i}$ as a fixed regressor (see, for example, Brown & Clarke, 1993; Bellamy, 1994).[6]

Models of the form (3) are typically troubled by the presence of heteroscedasticity and that is

[5] There is, throughout this literature, an implicit assumption that $\beta_0 = 0$.

[6] Aggregate movements up and down in the market are an element of noise in the data that must be taken into account (see, for example, Miller & Scholes, 1982). This is done by scaling the ex-dividend share price for the aggregate movement in the market. Thus

$$P_{x,i} = \frac{P^a_{x,i}}{1 + RI_{x,i}}$$

where $P^a_{x,i}$ is the observed ex-dividend day share price and $RI_{x,i}$ is the rate of return on the All Ordinaries Index over the ex-dividend day. We recognise that this adjustment is imperfect and that the potential for measurement error remains. However, such adjustments are common practice and enable comparison of results across the literature.

true in our data as well. One response to this problem is, of course, to simply estimate the model by OLS and to 'white-wash' the associated standard errors (White, 1980). Alternatively, one might also postulate a model for the variance of ε_i, σ_i^2, and use an asymptotically more efficient feasible GLS (FGLS) estimator. Two examples encountered in the literature are $\sigma_i^2 = \sigma^2 G_i^2$ (Brown & Walter, 1986) and $\sigma_i^2 = \sigma^2 P_{c,i}^2$ (Brown & Clarke, 1993). The approach adopted here is in a similar spirit with the FGLS estimator using weights from the auxiliary regression

$$\ln\hat{\varepsilon}_i^2 = \lambda_0 + \lambda_1 W_i + \lambda_2 G_i + \lambda_3 P_{c,i} + u_i, \quad i = 1, \dots, n$$

where the $\hat{\varepsilon}_i$ are OLS residuals from (3) and W_i is company size measured by market capitalisation as a proportion of the All Ordinaries Index.[7] This latter variable is included to reflect the fact that larger companies are generally more frequently traded and operate across more diversified lines of business, consequently they may have lower variance in their disturbance terms.

The model of Equation 3 assumes that the cash dividend and the associated franking credit can be combined as a single gross dividend variable, G. However, there are reasons to suspect the market may not value equally a dollar of cash dividend and a dollar of franking credit. For example, some large classes of institutional investors, such as superannuation funds and foreign investors, have limited ability to access Australian franking credits and as a result these investors value franking credits less than cash dividends. Furthermore, up until 2000, investors were not entitled to an income tax rebate for unused franking credits. This meant that franking credits held no value once they exceeded an investor's tax liability, and were therefore less valuable than the cash dividend. To allow for differential market valuation of cash dividends and franking credits, we shall expand (3) to

$$P_{c,i} - P_{x,i} = \gamma_0 + \gamma_1 D_i + \gamma_2 F_i + \varepsilon_i, \quad i = 1, \dots, n \quad (4)$$

We will term γ_1 the cash drop-off ratio and γ_2 the franking credit drop-off ratio. In every instance γ_0 was found to be insignificantly different from zero at the 5 per cent level.

As discussed in Bellamy and Gray (2004), correlation between the dividend and franking credit is a potential issue when estimating equations such as (4). For example, where the sample contains only dividends fully franked at the same company tax rate, the dividend and the franking credit will be collinear (e.g. $F_i = sD_i$). However, where the dataset incorporates information such as unfranked and partially franked dividends, observations at different company tax rates, observations where untaxed income is distributed (such as from listed property trusts), and observations where foreign-sourced company income does not attract a tax credit, the effects of multicolinearity should be mitigated.

If the dividend imputation system is fully effective at crediting final investors with the value of income tax paid at the company level, then cash dividends and franking credits will be equally valued. This proposition can be examined by the testing the hypothesis that $\gamma_1 = \gamma_2$. Indeed, a rejection of this hypothesis suggests that the models based on gross drop-off ratios, as found in much of the literature, do not produce accurate estimates of the relative values of cash dividends and franking credits. Furthermore, if this hypothesis is rejected, then the separate drop-off effects of cash dividends and franking credits must also be considered. The proposition that cash dividends are fully valued can be examined by testing whether $\gamma_1 = 1$, and the proposition that franking credits are fully valued can be examined by testing whether $\gamma_2 = 1$. If the hypothesis that $\gamma_1 = \gamma_2$ is not rejected, then the short-term trading hypothesis can be retested against the long term-trading hypothesis by testing whether $\gamma_1 = \gamma_2 = 1$.

As we mentioned above, there are reasons why franking credits may not be fully valued. Therefore it is also useful to test a stronger proposition about the value of franking credits, namely that the marginal investor places no value on franking credits, which can be examined by testing whether $\gamma_2 = 0$.

With this framework in mind, recall that we are also interested in examining the effects of the tax regime changes described in Appendix I. The likely impacts of these changes on the coefficients of models (3) and (4) are summarised in Table 1. In order to allow for these potential structural breaks we shall extend our models to take the form

$$P_{c,i} - P_{x,i} = \beta_0 + \sum_{j=1}^{7} \beta_{1,j} d_{i,j} G_i + \varepsilon_i, \quad i = 1, \dots, n \quad (5)$$

and

$$P_{c,i} - P_{x,i} = \gamma_0 + \sum_{j=1}^{7} \gamma_{1,j} d_{i,j} D_i + \sum_{j=1}^{7} \gamma_{2,j} d_{i,j} F_i + \varepsilon_i, \quad i = 1, \dots, n \quad (6)$$

[7] This generic model for the disturbance variance is also used with models discussed subsequently.

TABLE 1
Summary of the Expected Effects of Tax Regime Changes

Date[†]	Effect of tax change relative to previous regime	Likely implications
1988	Superannuation funds can use franking credits	β_1, γ_2 both larger
1990	Provisions to stop dividend streaming	β_1, γ_2 both smaller
1991	Limits to life assurance funds use of franking credits	β_1, γ_2 both smaller
1997	Provisions limiting related payments, holding period and delta hedge	β_1, γ_2 both smaller
1999	Capital gains tax reduced	β_1 smaller
2000	Tax rebate for unused franking credits	β_1, γ_2 both larger

[†] Tax regime changes occur at 1 July in the specified years.

respectively, where $j = 1, \ldots, 7$ indicates the tax regime in accordance with the scheme in Table 4 and

$$d_{i,j} = \begin{cases} 1, & \text{if observation } i \text{ occurs during tax regime } j \\ 0, & \text{otherwise} \end{cases}$$

IV Results

All of the data used in this study were collected from the CommSec Share Portfolio database. The sample period is 1 April 1986 to 10 May 2004. A more complete discussion of the data is presented in Appendix II.

Our results are reported as follows. Section (i) analyses estimated yearly gross drop-off ratios, cash drop-off ratios, and franking credit drop-off ratios. The results are discussed in the context of hypotheses developed in the previous section in respect of Equations 3 and 4. That is, our focus is on the respective valuations of cash dividends and franking credits. Section (ii) builds on the conclusions of Section (i) and considers whether there were structural breaks caused by tax regime changes, and whether these results are consistent with the hypotheses and predictions summarised in Table 1.

(i) Interpretation of Estimated Drop-off Ratios

The discussion begins with estimated gross drop-off ratios from equation (3), with the results summarised in Table 2.[8] Results are presented for the full dataset (based on all dividend events) and then two subsamples, a subsample of dividend events where no franking credits are paid and a subsample that contains only partially or fully franked dividends. For each dataset we report the estimated gross drop-off ratios ($\hat{\beta}_1$), their estimated standard errors (SE($\hat{\beta}_1$)), and the sample size used for each regression (n).

Using data for all dividends in the sample, we see that, for each year in the sample, estimated gross drop-off ratios are significantly less than unity. This is evidence that long-term traders, who are taxed more heavily on dividend income than on capital gains, dominate the ex-dividend day market-pricing event. Furthermore, it suggests that marginal investors do not trade up to the point where all arbitrage profits are extracted from the theoretical value of the gross dividend.

Looking at the subsample that contains only franked dividends a similar story emerges, with estimated gross drop-off ratios significantly less than unity for each year of the sample. Moreover, the estimated gross drop-off ratios for this subsample are very close to those estimated for the complete sample, which is not surprising as stocks paying franked dividends numerically dominate the complete sample.

For the subsample of unfranked dividends, estimated gross drop-off ratios, which for this sample are the same as cash drop-off ratios, are not significantly less than unity in the period 1990–2003. This suggests that when no franking credit is attached to the dividend marginal investors trade up to the point where all potential arbitrage profits are extracted from the ex-dividend event.[9] This result is consistent with Cannavan *et al*. (2004) who conclude that investors place the same value on a dollar of cash dividends as a dollar of future profit. The differences between the estimates of β_1 for franked and unfranked dividends provide evidence that markets do not fully value the franking credit component of dividends.

[8] In reporting results, the year in the tables refers to the financial year ending 30 June. For example, 1996 refers to the financial year ending 30 June 1996.

[9] One might speculate that this is going to be an attractive strategy in a thin market where any volume of trade will tend to shift the price, although this remains a topic for another time.

TABLE 2
Estimated Gross Drop-off Ratios

Year ended 30 June	All dividends			Unfranked dividends			Franked dividends		
	n	$\hat{\beta}_1$	SE ($\hat{\beta}_1$)	n	$\hat{\beta}_1$	SE ($\hat{\beta}_1$)	n	$\hat{\beta}_1$	SE ($\hat{\beta}_1$)
1986	336	0.600*	0.155	336	0.600*	0.155	0		
1987	314	0.520*	0.176	310	0.517*	0.181	4	†	
1988	260	0.479*	0.109	100	0.561*	0.183	160	0.473*	0.130
1989	300	0.433*	0.063	101	0.432*	0.127	199	0.460*	0.072
1990	246	0.628*	0.048	69	0.249	0.258	177	0.698*	0.045
1991	236	0.574*	0.048	50	0.782	0.164	186	0.614*	0.052
1992	225	0.537*	0.061	43	0.871	0.117	182	0.554*	0.068
1993	263	0.618*	0.052	64	0.983	0.196	199	0.640*	0.062
1994	272	0.464*	0.062	64	0.689	0.224	208	0.442*	0.071
1995	292	0.561*	0.046	76	0.811	0.123	216	0.612*	0.054
1996	303	0.633*	0.040	85	0.994	0.117	218	0.656*	0.046
1997	314	0.654*	0.045	85	0.770	0.164	229	0.697*	0.051
1998	302	0.705*	0.066	72	0.707	0.200	230	0.777*	0.076
1999	271	0.703*	0.059	79	0.681	0.148	192	0.738*	0.074
2000	267	0.611*	0.051	78	0.720	0.197	189	0.659*	0.066
2001	287	0.699*	0.062	68	0.658	0.200	219	0.731*	0.069
2002	299	0.778*	0.071	70	0.742	0.157	229	0.861*	0.077
2003	418	0.704*	0.041	100	0.690	0.148	318	0.743*	0.045
2004	306	0.753*	0.039	74	0.385*	0.095	232	0.788*	0.042
Total	5511			1924			3587		

* Indicates significantly less than unity at the 5 per cent level.
† The subsample of franked dividends in 1987 was not large enough to estimate the drop-off ratio separately for this subsample.
SE, standard error.

Segmentation of the sample is just one way to address the issue of how the market assigns value to franking credits. As discussed in Section III, an alternative approach is to separate the cash and franking credit components of the gross dividend as modelled in (4). The results of FGLS estimation of (4) over the complete sample of dividends are reported in Table 3.[10]

In the first year of imputation, 1987, and in the years following the introduction of a tax rebate for unused franking credits, 2002–2004, the drop-off ratios for the cash dividend and for the franking credit were not significantly different from each other. This suggests that, at least in those periods, investors equally valued cash dividends and franking credits. However, the null hypothesis that these coefficients are jointly equal to 1 ($\gamma_1 = \gamma_2 = 1$) is rejected, providing further evidence that marginal investors do not trade up to the point where all excess arbitrage profits are extracted from the theoretical value of the gross dividend.

In all the years from 1988 to 2001, the estimated drop-off ratios for the cash dividend and the franking credit were significantly different from each other. This result strongly suggests that analysis based on the estimation of a single gross drop-off ratio is an inappropriate approach to understanding these market phenomena.

An important extension to this finding is that in the years from 1987 to 1997, and in 2000, the impact of the franking credit on the ex-dividend day price change was not significantly greater than zero. This result suggests that the market placed no value on franking credits during most of the sample period, which is consistent with the findings of Bellamy and Gray (2004), and, because investors undervalued franking credits, the gross drop-off ratios are driven below 1. Similarly, using ISF and LEPO unique to the Australian market, Cannavan *et al*. (2004) concluded that the value of imputation

[10] We note that Table 3 contains some large standard errors for the estimates of γ_2 although this is not an issue for the estimates of γ_1 and so we do not believe that multicolinearity is a major cause for concern in this dataset. Potentially of greater concern might be the impact of measurement error on the standard errors for our estimates of γ_2. For any given dataset, it is difficult to be sure of the extent to which measurement error is a problem; we refer to the discussion in footnote 6.

Table 3

Estimated Cash and Franking Credit Drop-off Ratios

Year ended 30 June	All dividends							
	$\hat{\gamma}_1$	SE ($\hat{\gamma}_1$)	$\hat{\gamma}_2$	SE ($\hat{\gamma}_2$)	P_1	P_2	$\hat{\gamma}_1 \mid \hat{\gamma}_2 = 0$	SE ($\hat{\gamma}_1 \mid \hat{\gamma}_2 = 0$)
1986							0.600*	0.155
1987	0.514*	0.177	0.691	0.579	0.594	0.016	0.519*	0.180
1988	0.582*	0.151	0.248*	0.236	0.000		0.618*	0.160
1989	0.569*	0.092	0.188*	0.140	0.000		0.661*	0.098
1990	0.876	0.131	0.215*	0.175	0.000		0.931	0.090
1991	0.892	0.110	0.092*	0.154	0.000		0.894	0.077
1992	0.912	0.092	–0.088*	0.140	0.000		0.892	0.093
1993	1.104	0.132	–0.099*	0.176	0.000		1.037	0.085
1994	0.526*	0.151	0.366*	0.197	0.002		0.723*	0.104
1995	0.923	0.098	–0.038*	0.155	0.000		0.895	0.071
1996	0.874	0.102	0.231*	0.158	0.000		0.991	0.060
1997	0.943	0.110	0.197*	0.168	0.000		1.046	0.069
1998	0.818	0.138	0.509*,†	0.222	0.028		1.095	0.104
1999	0.848	0.118	0.440*,†	0.188	0.003		1.079	0.093
2000	0.843	0.113	0.242*	0.187	0.000		0.943	0.081
2001	0.817	0.131	0.506*	0.233	0.035		1.018	0.092
2002	0.769	0.128	0.732*,†	0.284	0.345	0.004	1.105	0.094
2003	0.728*	0.093	0.678†	0.193	0.097	0.000	0.939	0.059
2004	0.811	0.108	0.631†	0.229	0.109	0.000	0.997	0.057

* Indicates significantly less than unity at the 5 per cent level.
† Indicates significantly greater than zero at the 5 per cent level.
P_1 is the P-value of the F-test of $\gamma_1 = \gamma_2$.
P_2 is the P-value of the F-test of $\gamma_0 = 0$ and $\gamma_1 = \gamma_2 = 1$ given $\gamma_1 = \gamma_2$.
SE, standard error.

credits was statistically indistinguishable from zero over this period.

If marginal investors do not value the franking credit for most of the sample, it is interesting to then focus on just the cash drop-off ratio. Under the hypothesis that the market placed no value on franking credits, (4) can be estimated assuming $\gamma_2 = 0$, and then the cash drop-off ratio is estimated by γ_1. These results are shown in the final two columns of Table 3.

Observe that from 1990 to 1993, and from 1995 to 2004, the cash drop-off ratio was not significantly less than 1. In all the other years the estimated cash drop-off ratio was close to 1 in a qualitative sense, but the data allow us to reject the null hypothesis that the cash drop-off ratio was exactly 1. This result is consistent with a variant of the short-term trading hypothesis that arbitrageurs extracted most of the value in the potential cash (non-tax) arbitrage.

(ii) Impact of Tax Regime Changes

One lesson from the previous section is that the valuation of franking credits appears to have changed with time. In this section we examine more carefully the notion of structural breaks arising as consequences of the tax regime changes reviewed in Appendix I. The discussion will focus around the test statistics reported in Table 4, for gross drop-off ratios, and Table 5, for franking credit drop-off ratios.

Tax Change 1988

The tax change in 1988 was expected to increase both the estimated gross drop-off ratio and the value of franking credits. Empirical results indicate that both the gross drop-off ratio and the franking credit drop-off ratio fell from 1988 to 1989. However, comparing longer term trends in the drop-off ratios we see that, on average, the gross drop-off ratio was significantly larger during the 1989–1990 period than it was during the 1986–1988 period, whereas there was no statistically discernible difference between the average franking credit drop-off ratios during the two periods. This implies that the tax regime change had a significant impact on the gross drop-off ratio, but not on the value of franking credits.

TABLE 4
Tests for Structural Breaks in Gross Drop-off Ratios

Tax regime	Period	Estimated gross drop-off ratio ($\beta_{1,j}$)	Null hypothesis	*P*-value
1	1986–1988	0.466 (0.034)	$\beta_{1,1} = \beta_{1,2} = \ldots = \beta_{1,7}$	0.000
2	1989–1990	0.564 (0.025)	$\beta_{1,1} = \beta_{1,2}$	0.011
3	1991	0.613 (0.035)	$\beta_{1,2} = \beta_{1,3}$	0.231
4	1992–1997	0.617 (0.015)	$\beta_{1,3} = \beta_{1,4}$	0.918
5	1998–1999	0.654 (0.021)	$\beta_{1,4} = \beta_{1,5}$	0.112
6	2000	0.743 (0.028)	$\beta_{1,5} = \beta_{1,6}$	0.008
7	2001–2004	0.724 (0.013)	$\beta_{1,6} = \beta_{1,7}$	0.512

The numbers in parentheses are estimated standard errors and the *P*-values are from conventional *F*-tests of the hypotheses.

TABLE 5
Tests for Structural Breaks in Franking Credit Drop-off Ratios at Tax Regime Changes

Tax regime	Period	Estimated cash drop-off ratio ($\gamma_{1,j}$)	Estimated franking credit drop-off ratio ($\gamma_{2,j}$)	Null hypothesis	*P*-value
1	1986–1988	0.465 (0.040)	0.752 (0.157)	$\gamma_{2,1} = \gamma_{2,2} = \ldots = \gamma_{2,7}$	0.000
2	1989–1990	0.646 (0.064)	0.450 (0.119)	$\gamma_{2,1} = \gamma_{2,2}$	0.126
3	1991	0.765 (0.115)	0.376 (0.206)	$\gamma_{2,2} = \gamma_{2,3}$	0.757
4	1992–1997	0.861 (0.059)	0.201 (0.103)	$\gamma_{2,3} = \gamma_{2,4}$	0.447
5	1998–1999	0.795 (0.099)	0.418 (0.186)	$\gamma_{2,4} = \gamma_{2,5}$	0.305
6	2000	1.168 (0.099)	0.128 (0.204)	$\gamma_{2,5} = \gamma_{2,6}$	0.047
7	2001–2004	0.800 (0.052)	0.572 (0.121)	$\gamma_{2,6} = \gamma_{2,7}$	0.003

The numbers in parentheses are estimated standard errors and the *P*-values are from conventional *F*-tests of the hypotheses.

This is consistent with the results observed by Brown and Clarke (1993).

Tax Change 1990

The 1990 tax change lead to the prediction that after July 1990, both the gross drop-off ratio and the franking credit drop-off ratio would decrease. Indeed this result was observed; however, tests suggest these changes were not statistically significant.

Tax Change 1991

After July 1991, the gross drop-off ratio and the franking credit drop-off ratio were predicted to fall. The empirical results show that the estimated drop-off ratio initially fell in 1992, as the theory predicts, but bounced around in the subsequent years. The estimated franking credit drop-off ratio followed a similar path, falling in 1992, but moving up and down in the following years.

Although the behaviour after 1992 appears inconsistent with the theory, there are reasons why such results might be expected. As discussed in Appendix I, up until July 2000, investment returns of institutional investors significantly affected the market value of franking credits. Before tax refunds for unused franking credits were made available in 2000, investors receiving franking credits in excess of their tax payable could get no value for the unused franking credit. Hence, in years when the investment returns of large institutional investors were low, the tax liability of these institutional investors would be small or even negative, thus the value of (marginal) franking credits to these investors should have been zero. Similarly, when the investment returns of large institutional investors were high, the tax liability of these investors should have increased; hence the value of franking credits to these investors should have been large. Because institutional investors such as superannuation funds are big enough to influence market prices, it follows that the market value of franking credits, and therefore the franking credit drop-off ratio, will be influenced by the tax position of these institutional investors.

The investment market suffered considerable losses in the recession years 1990–1991 and slowly recovered through the mid-1990s. Because returns to large institutional investors were low during the early 1990s, franking credit drop-off ratios are expected to be low in this period. The investment market began to recover in the mid-1990s, and therefore the franking credit drop-off ratio should increase in this period. There is some mild evidence of this behaviour in the pattern of observed estimates of γ_2. Franking credit drop-off ratios fell considerably in the years 1991 and 1992, and then slowly began to increase. However, the franking credit drop-off ratio was not significantly different from zero during the period 1992–1997, and a test for structural break between 1991 and 1992–1997 suggests that changes in the estimated franking credit drop-off ratio were not statistically significant.

Tax Change 1997

After June 1997, both the estimated franking credit drop-off ratio and the estimated gross drop-off ratio were expected to fall. The estimated gross drop-off ratios increased in both 1998 and 1999, while the estimated franking credit drop-off ratio increased in 1998 and fell in 1999. These results are consistent with the findings of Bellamy and Gray (2004), who also observed an increase in the value of franking credits after 30 June 1997. This can be compared with Cannavan *et al*. (2004), who found evidence of a slight decline in the value of imputation credits after the introduction of the July 1997 tax change, and concluded that imputation credits had become effectively worthless to the marginal investor of ISF and LEPO. However, ambiguous results around this tax change are not unexpected. As mentioned earlier, the 2-year legislative delay in implementing the June 1997 tax regime changes resulted in considerable uncertainty about the final form of the law. This delay likely muted the impact of the structural break so that the impact in any one given year is probably not large enough to detect. Tests for structural breaks between the periods 1992–1997 and 1998–1999 show that the estimated gross drop-off ratios and estimated franking credit drop-off ratios did not change significantly.

Tax Change 1999

The 1999 tax change led to a prediction that the estimated gross drop-off ratio would decrease in 2000. Results show that the estimated gross drop-off ratio did decrease, falling from 0.7 in 1999 to 0.6 in 2000, which is consistent with the developed theory. However, the test for a structural break between 1998 and 1999 and 2000 suggests that the gross drop-off ratio actually increased in 2000, which is inconsistent with the theory.

Tax Change 2000

Finally, it was predicted that the 2000 tax change would cause an increase in both the estimated franking credit drop-off ratio and the estimated gross drop-off ratio after July 2000. The estimated franking credit drop-off ratio increased in 2001 and 2002, which is consistent with the theory. A slight downward trend is noticed in 2003 and 2004. However, it appears that this tax change had a permanent positive impact on the value of franking credits. This result is confirmed by a test for structural breaks whereby the interval 1998–2000 is compared to 2001–2004. The test shows that the franking credit drop-off ratio was significantly higher in 2001–2004. Estimates of the gross drop-off ratios show a similar pattern. The estimated gross drop-off ratios increased in 2001 and 2002, but dropped slightly in 2003 and 2004. However, tests for structural breaks suggest that the gross drop-off ratio was not significantly different between 2000 and 2001–2004.

These results add strength to the argument that because investors did not value excess franking credits before the tax change in 2000, franking credits were significantly undervalued, and estimated gross drop-off ratios were relatively low. It follows that because investors could extract more value from franking credits after the tax change in 2000, both the franking credit drop-off ratio and the gross drop-off ratio permanently increased.

This final result, combined with the conclusions from Section (i), has an important practical interpretation. It suggests that the most recent tax regime change, that finally allowed a tax rebate on unused franking credits, significantly increased the value of franking credits to the marginal investor.

(iii) Robustness Tests

As discussed earlier, market microstructure effects are a potential explanation for why drop-off ratios do not behave according to theory. In particular, the effects are likely to be more pronounced for lower priced shares. In an attempt to explore the robustness of the results reported in Tables 4 and 5, we re-estimated Equations 5 and 6 using subsamples comprised of lower and higher priced shares; specifically, shares with ex-dividend day prices less than or greater than and equal to $5, respectively.[11]

The key findings of this experiment were that there were no systematic differences observed either between each of the subsamples and the full sample or between the two subsamples. Indeed, tests of coefficient stability across the subsamples were unable to reject the null hypothesis of the two models being the same. This experiment, while not definitive, suggests that the results presented are reasonably robust to market microstructure effects.

V Conclusion

This paper analyses the ex-dividend behaviour of share prices in the Australian market from 1986 to 2004. We estimate the gross drop-off ratios, cash drop-off ratios and franking credit drop-off ratios, and consider how these ratios changed in response to changes in the tax regime.

Consistent with much of the literature, the empirical findings show that the gross drop-off ratios were significantly less than 1 over the entire sample period. This provides evidence that marginal investors in the form of arbitrageurs did not trade up to the theoretical value of the gross dividend. It was then found that cash drop-off ratios were consistently close to 1, but the franking credit drop-off ratios were significantly less than 1. Moreover, the franking credit drop-off ratios were not significantly different from zero for much of the sample data. This indicates that marginal investors did not value the franking credit, and provides an explanation as to why gross drop-off ratios less than 1 were observed.

The impacts of six tax regime changes were then considered. The effects of tax changes were found to be generally consistent with developed theory, but few statistically significant effects could be identified for most of the tax changes. Importantly, the year 2000 tax change that allowed for a tax rebate of unused franking credits was of special interest. This tax regime change permanently increased the value of franking credits to the marginal investor, and raised the estimated gross drop-off ratio. Remembering that the government introduced the dividend imputation system to remove the distortional effects of double taxation, this tax change resulted in more efficient market pricing mechanisms because it finally allowed the marginal investors to extract a substantial component of the benefit of the franking credit.

[11] We thank an anonymous referee for this suggestion.

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Appendix I
Changes to the Dividend Imputation System: Australia 1988–2000

1988

In July 1988, superannuation funds, selected deposit funds, and friendly societies were for the first time required to pay income and capital gains taxes at a rate of 15 per cent. To offset this impost, these three classes of investor also became eligible to use the franking credits system.[12] In addition, insurance funds of life assurance companies also became eligible to use the franking credits system. Since superannuation funds became for the first time liable for income tax and their tax liability could be reduced with franking credits, the prediction is that their demand for franking credits would rise. Similarly, insurance funds could now use franking credits to reduce their tax liability. In summary, both the gross drop-off ratio, β_1, and the franking credit drop-off ratio, γ_2, should have increased after July 1988.

1990

In 1990, taxation laws were introduced to stop companies allocating franking credits to those classes of shareholders who put the most values on franking credits. These so-called 'dividend streaming' provisions stopped companies issuing two classes of shares, one paying franked dividends and the other paying unfranked dividends. Under these streaming schemes,

[12] Commonwealth of Australia (1989).

investors with low tax liability in Australia, such as foreign investors or certain domestic institutions, were given shares paying a higher cash dividend, but with no attached franking credits. Other amendments disallowed the use of franking debits that arose when companies bought back their own shares. Together these amendments further reduced the ability of investors to extract the full value of franking credits. Therefore after July 1990, both the gross drop-off ratio, β_1, and the franking credit drop-off ratio, γ_2, should have decreased.

1991

In August 1991, taxation laws were introduced that effectively excluded mutual life assurance companies from the dividend imputation provisions. These changes also provided for reduced franking credits and debits for non-mutual life assurance companies.[13] Also, additional provisions were enacted to exclude friendly societies and other registered organisations from the imputation system. As a result, both the gross drop-off ratio, β_1, and the franking credit drop-off ratio, γ_2, should have decreased after 30 June 1991.

1997

In May 1997, the government announced two sets of measures to limit the use of franking credits. One set of measures that was made effective immediately, but not enacted until 1999, prevented franking credit trading by foreign companies or exempt entities.[14] These measures are known as the related payments rule. In a simplified example of such a transaction, an Australian investor borrows stock from a foreign investor and pays a borrowing fee. The borrowing fee incorporates a cost of funds, being forgone dividend income, plus a premium that effectively transfers part of the tax benefit of the domestic borrower back to the foreign investor.

The second set of measures was made effective from July 1997, but also not enacted until 1999. Known as the holding period rule, these measures required that traders hold a share for 45 days around the ex-dividend date in order to gain entitlement to the franking credit. The holding period rule stopped investors from trading around the ex-dividend for the sole purpose of obtaining franking credits. Additional measures stipulated that upon receiving the franking credit, the investors could not fully hedge away their exposure to market risk. Investors seeking to claim franking credit had to remain at least 30 per cent exposed to movements in the value of the underlying stock. This requirement is known as the 30 per cent delta rule.

Both measures introduced in May 1997 reduced the capacity of important classes of investors to use franking credits, and so it should be expected that the demand for franking credits fell. Although these tax changes should have impacted the market from July 1997, there are reasons why the initial impact might have been small. Legislation supporting these tax changes was retrospective law, and was not enacted until 2 years after the announcement. The exact scope of the legislation was not known for a long while and there were technical difficulties deciding how the concept of a 30 per cent delta rule was to be measured. However, the proposition that both β_1 and γ_2 should be smaller after 30 June 1997 can be examined.

1999

The most notable changes in capital gains tax laws occurred in September 1999, but were made effective from July 1999. Capital gains tax rates were significantly reduced for individuals and superannuation funds. The capital gains tax for individuals was reduced from a maximum of 47 per cent to no more than 24.45 per cent, and capital gains tax for superannuation funds was reduced from 15 per cent to 10 per cent. Against these benefits, price indexation for capital gains was frozen as of 30 September 1999.[15] These changes had the effect of significantly increasing the value of capital gains relative to dividends, thus the gross drop-off ratio, β_1, should have decreased.

2000

In July 2000, individuals and superannuation funds became entitled to a tax refund for their excess or unused franking credits. Previously,

[13] Commonwealth of Australia (1991).
[14] Commonwealth of Australia (1999).

[15] Capital assets purchased before 30 September 1999 and held for 1 year remained subject to indexation discounting, while any capital assets purchased after 30 September 1999 and held for 1 year became subject to the new discounting method. The new discounting method stated that for assets purchased after 30 September 1999, individuals paid capital gains tax on 50 per cent of the gain, and superannuation funds paid tax on 66.6 per cent of the gain.

when an individual or superannuation fund received franking credits above their payable tax, they were not entitled to any benefit from unusable credits. While it seems likely that most personal investors would have been using their available franking credits, it is well known that many superannuation funds did not pay tax because they had excess franking credits. The July 2000 changes created real value in previously unused franking credits, creating an incentive for this large class of investors to actively seek franking credits. It is easy to see that this regime change should have increased the franking credit drop-off ratio, γ_2, and thus increased the estimated gross drop-off ratio, β_1.

Appendix II

The Data

Data are for companies and trusts whose primary listing is on the Australian Stock Exchange. The dataset has been filtered to remove all observations where the dividend payment, the corporate tax rate, the cum-dividend share price or the ex-dividend share price was not known. In practice, this filter removed only a small number of observations. Those observations that were removed had no unifying feature other than the missing data. It follows that this filter should have no significant impact on the estimation and results.

A second filter eliminated all cases where the market capitalisation of a company was not reported, or where the weight of market capitalisation in the All Ordinaries index was less that 0.03 per cent.[16]

It has been shown that the results of ex-dividend day studies are very sensitive to company events occurring close to the ex-dividend day.[17] Following Brown and Clarke (1993), the dataset was screened for any companies that changed their basis for quotation within 5 days either side of the ex-dividend day. Special dividend payments were also removed. Special dividends are an irregular distribution of excess cash reserves, and for this reason it is expected that prices may behave inconsistently around special dividend payments.

Finally, data from the extremely volatile month of October 1987 were removed. The history of the Australian share market suggests that price volatility in that month was the highest measured over the past 100 years. The presence of the October 1987 data in this sample could distort interpretation of results. After sorting, the dataset contains 5511 ordinary dividend events from 1 April 1986 to 10 May 2004. A more complete collection of descriptive statistics for the dataset may be found in Beggs and Skeels (2005, table 7), where it should be noted that the units of measurement for the dividends are Australian dollars.

[16] Although market capitalisation alone is not critical to the analysis, companies with very small market capitalisations tend to be rarely traded on the stock exchange. Therefore the market pricing mechanisms for firms with small market capitalisations are not efficient, and the price changes on the ex-dividend date will be an unreliable measure of true scarcity. The cut-off figure of 0.03 was suggested by Andrew Poppenbeck, the manager of Comm-Sec Share Portfolio Database.

[17] Black and Scholes (1974).