The Effects of Dividend Taxes on Equity Prices: A Re-Examination of the 1997 UK Tax Reform

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Abstract

We re-examine the extent to which personal taxes on dividends are capitalised into the equity prices of domestic firms, using data from around the time of the 1997 UK dividend tax reform, which removed a significant tax credit for an important group of investors: UK pension funds. The tax-adjusted CAPM suggests that the impact should depend on an average of dividend tax rates across all investors, and that UK pension funds should reduce their holdings of the previously tax-favoured asset: UK equities. Given that UK pension funds are small relative to the total size of the world capital market, a small open economy-type argument implies that the main effect of the reform would be to reduce UK pension funds' ownership of UK equities, with little impact on the price of UK equities. We present evidence which is consistent with these hypotheses. We discuss why previous research (Bell and Jenkinson, 2002) reached the different conclusion that this tax reform had a large negative impact on UK share prices.

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1 Introduction

Recent years have seen important reforms of dividend taxation in several OECD countries. In 2003, the USA moved away from a pure classical system, introducing preferential personal tax rates for dividend income. In 1999, Ireland moved in the opposite direction, replacing a partial imputation system with a classical system, in which dividend income is taxed at the shareholder's full marginal income tax rate. The operation of imputation systems in European Union countries has been held to be inconsistent with the EU Treaty in a series of rulings by the European Court of Justice, generally involving discrimination against either foreign shareholders or foreign corporations. Several EU countries have modified or abandoned their imputation systems as a result. Both Germany and the UK now tax dividends in a similar way to the current US system, with dividends subject to personal income tax, but not taxed at the shareholder's full marginal income tax rate.[1] In Ireland, Germany and the UK, revenue raised from these dividend tax increases has been used to finance reductions in the corporate income tax rate.

For any assessment of these reforms, an important question is whether dividend taxes have any significant effect on corporate investment decisions. The public economics literature suggests two distinct reasons why dividend taxation may have little relevance for corporate investment. The 'new view' or 'tax capitalisation' hypothesis accepts that dividend taxes will be capitalised into share prices, but emphasises that taxes on dividends will still have no effect on the cost of capital or investment, if the marginal source of finance used by firms is retained earnings and the dividend tax rate is constant. The classical statements of this result are in King (1974) and Auerbach (1979), and the intuition is straightforward. Suppose that dividend income is taxed at rate m, so that the shareholder gives up net income of $\$(1-m)$ to finance an investment of \$1 from retained earnings. When the return from the investment - say $\$(1+r)$ - is paid out as a dividend, the shareholder receives $\$(1-m)(1+r)$, so that the post-tax rate of return (r) is

[1] For legal reasons linked to bilateral tax treaties, the UK still formally operates a dividend tax credit. For domestic shareholders this is equivalent to income tax at a preferential rate, and the remaining tax credit has negligible value for foreign shareholders.

the same as the pre-tax rate of return. For investment financed from retained earnings, the dividend tax acts as a cash flow tax, and is neutral with respect to the investment decision. Of course, this argument does not hold if the marginal source of finance is new equity, and the return is paid out at least partly in the form of a dividend.[2] It is possible therefore that dividend taxation acts as a disincentive to investment by immature firms, that are more reliant on new equity finance.[3] But since most investment is undertaken by mature corporations and since most of their investment is financed from retained earnings, dividend taxation is expected to have only a limited effect on aggregate investment.

A different argument that leads to broadly the same conclusion is the 'tax irrelevance' view, which suggests that dividend taxes have little or no effect on share prices. As first stated by Miller and Scholes (1978), the argument is that share prices are determined by the trading decisions of large, tax-exempt financial institutions like pension funds, that do not pay tax on their dividend income. If the 'marginal' shareholder does not pay the dividend income tax, neither stock market valuations nor value-maximising investment decisions should be influenced by dividend tax rates. A related argument has been made in the context of small open economies by Boadway and Bruce (1992). In their model, the rate of return on domestic investment is determined either by the rate demanded by foreign shareholders (for capital importers), or the rate available on outbound investment (for capital-exporters). Both of these rates are determined on the world market and are unaffected by domestic taxes on dividends. Boadway and Bruce do not explicitly consider the market value of equity, since they assume that the domestic firm maximises the utility of the domestic shareholder, rather than the market value. However, where the firm is partly owned by foreign investors, then these foreign investors are effectively the 'marginal' shareholders, and the firm's market value is independent of domestic taxes on dividends. Fuest and Huber (2000) also assume that foreign investors are the marginal shareholders.

[2]Edwards and Keen (1983) made more precise the result that neutrality holds as long as the marginal source of finance is the same when the investment is made and when the returns are paid to shareholders (and as long as the dividend tax rate is constant).

[3]See, for example, Sinn (1991). Recent papers that test predictions of the 'new view' include Auerbach and Hassett (2002, 2005) and Chetty, Rosenberg and Saez (2004, 2005).

The assumption that share prices depend only on the tax treatment of one class of investors is difficult to reconcile with asset pricing theories based on optimal portfolio allocation by risk averse investors. However the finance literature provides a model that, at least in a small open economy context, leads to broadly similar predictions as the model of Boadway and Bruce (1992). This is the tax-adjusted capital asset pricing model (CAPM), first set out by Brennan (1970), in which different investors may face different tax rates on dividend income. This approach makes no assumption about the identity of 'the' marginal shareholder. In contrast, all investors can be 'marginal' in the sense of being just willing to hold the equity at the ruling market price, even though tax rates may differ both across investors and across assets. This is possible because they are also concerned about the risk they bear by holding risky assets. In equilibrium, an investor with a lower tax rate on a specific asset will tend to hold more of that asset, but at the cost of holding a less diversified, and hence more risky, portfolio.

In this model, the effect of dividend taxes on share prices depends on an average of tax rates across all investors. It does not matter that shares in a specific asset may be held predominantly by one group of shareholders; the relative ownership of a particular asset across different types of investors is irrelevant. What does matter is the relative total wealth of different investors. In the context of a small open economy, this implies that dividend income taxes on domestic investors are likely to be irrelevant to the tax capitalisation effect. If firms choose investment to maximise their stock market valuations, this again implies that domestic dividend taxation will have little or no effect on investment.[4]

The 1997 dividend tax reform in the UK provides an interesting opportunity to test these predictions. As we explain in more detail in section 2, before this reform, UK pension funds and insurance companies managing pension-related assets could reclaim part of the corporate income tax paid by firms on the underlying profits, when they received dividends paid by UK companies. These rebates cost the UK

[4]If most stock market wealth is controlled either by (domestic or foreign) tax-exempt institutions or by foreign investors who can avoid paying income tax on dividends paid by domestic firms, this would further imply the Miller-Scholes view that dividend taxation in general is largely irrelevant for stock market valuations. However this stronger implication is not needed for the hypotheses we investigate in this paper.

government around £5bn per annum, equivalent to about 20% of UK corporation tax revenue. Before 1997, UK pension funds alone owned around 30% of all UK equities, and held approximately three quarters of their equity holdings in UK companies. These rebates were abolished by the new Labour government in its first Budget in July 1997. The post-tax value of a given cash dividend paid by a UK firm to a UK pension fund fell by 20%, while other shareholders - both UK and foreign - were largely unaffected by this reform.

Extending the argument of Miller and Scholes (1978) - that share prices are largely determined by the valuation of domestic financial institutions that own the largest shares of these assets - to this UK setting, Bell and Jenkinson (2002) suggested that this reform of UK dividend taxation caused a significant fall in the value of the UK stock market. To support this claim, they studied the behaviour of share prices on ex-dividend days - the day on which the owner of the share ceases to be entitled to a recently announced dividend payment. If UK pension funds were 'the' marginal investors, then the ex-dividend day fall in the market value of a UK company paying £100 of cash dividends should have been £125 (including the rebate of underlying corporation tax) before the 1997 reform and £100 after the reform. Equivalently the 'drop-off ratio' (the change in the market value expressed as a proportion of the cash dividend) should have fallen from 1.25 to 1, a fall of 20%. In contrast, the tax-adjusted CAPM predicts that this reform of UK dividend taxation should have had essentially no effect on either share prices or drop-off ratios. UK pension funds would be expected to reduce their holdings of UK equities, as the tax advantage that induced them to bear more UK-specific risk was eliminated. But since UK pension funds are small relative to the world capital market, this portfolio reallocation should have little or no effect on UK share prices.

As a first step towards considering more detailed empirical evidence, it is useful to review movements in the UK stock market index on and after the announcement of the 1997 tax reform. The FTSE 100 index is presented in Figure 1, between 1995 and 2002. As is well known, there was considerable volatility in the stock market during this period, with the index almost doubling between 1995 and 1999

before falling back. The date of the 1997 tax reform is marked by the vertical line. If equity valuations had followed the Bell-Jenkinson prediction, then, *ceteris paribus*, there should have been a fall of around 20% in the value of the index on the announcement of the reform. Clearly, this did not happen. Instead the index continued to rise. It is conceivable that other announcements in Gordon Brown's first Budget may have overshadowed the dividend tax reform. However, it is difficult to think of precedents for announcements of changes in economic policy producing the required 20% rise in the stock market, at least in developed countries.

Nevertheless, Bell and Jenkinson (2002) find that the mean drop-off ratio for listed UK companies fell significantly after this tax reform, although their central estimate is from around 1.05 to 0.85. We confirm their finding in our empirical analysis; however we do not share their conclusion that UK share prices are determined by the valuations of UK pension funds.

Our doubts about their conclusion are based both on the theoretical claim that one type of shareholder should be 'the' marginal investor in a market where the same assets are held simultaneously by different investors facing different tax rates; and the methodological concerns about inferring the impact of dividend taxes on share prices from fluctuations in the mean drop-off ratio, that have been highlighted recently by Chetty, Rosenberg and Saez (2005). To support this, we present a more detailed empirical study of the behaviour of ex-dividend day drop-off ratios in the UK, both around the 1997 tax reform and over a longer period. While the mean drop-off ratio did fall significantly in the second half of the 1990s, further analysis reveals that this fall was associated with a sharp increase in the proportion of observations where the share price *rose* on the ex-dividend day, generating a negative value for the drop-off ratio. It is not clear how this development could be related to the dividend tax reform. A similar pattern was observed in the late 1980s, with the mean drop-off ratio being low and the proportion of observations with negative values being high in the period after the 1987 stock market crash. There were no changes to the tax treatment of UK pension funds that could explain these patterns in the late 1980s. In line with

Chetty, Rosenberg and Saez (2005), we conclude that the mean drop-off ratio in the UK is too volatile for short term fluctuations around tax reforms to provide reliable evidence on the effects of dividend taxation on the stock market valuation of firms.[5]

In a companion paper, we investigated more directly whether the 1997 UK dividend tax reform affected the investment behaviour of UK companies, and found no significant effect.[6] Our findings in this paper are consistent with that result, but also provide an explanation for why there should be no effect of UK dividend taxation on UK corporate investment. At least in the UK context, this does not seem to be explained by the standard 'new view' argument, which would imply a significant tax capitalisation effect on share prices. Rather, it appears to reflect the size of the UK and the openness of its capital market. Consistent with the tax-adjusted CAPM in a small open economy setting, there is no significant effect of domestic dividend taxes on UK share prices, and hence no impact on investment by UK companies.

In the next section we present a brief summary of the UK dividend tax regime before and after the 1997 reform. Following that, in Section 3 we outline a simple version of the Brennan (1970) tax-adjusted CAPM model, which serves to highlight the features of the market which are important in determining prices. In Section 4, we summarize the empirical predictions of the model and set out how we implement empirical tests. Section 5 presents the data, and Section 6 the results. We conclude in Section 7.

2 The Taxation of Dividends in the UK

We briefly summarize the main elements of the dividend tax regime both before and after 1997.[7] From the early 1970s until 1999, the UK operated a partial

[5] Chetty, Rosenberg and Saez (2005) document similar volatility over time in the behaviour of the mean drop-off ratio in the US. Interestingly their estimates show that there was also a sharp fall in the mean drop-off ratio in the US in the second half of the 1990s, although there was no similar tax change in the US that would explain this development.

[6] Bond, Devereux and Klemm (2005).

[7] A more detailed description of the tax system is provided in Bond et al (2005), where we investigate the impact of the 1997 reform on company dividend payments and investment.

imputation system. On paying a cash dividend, UK firms were obliged to pay a proportion of the dividend in tax: Advance Corporation Tax (ACT). Subject to restrictions (principally that the dividend did not exceed UK taxable profit), the ACT could be credited against the main corporation tax charge, and thus generally only affected the timing of corporation tax payments. In addition, however, UK shareholders could also claim a credit against the UK income tax due on the receipt of the dividend. In general, ACT was charged at the basic rate of income tax (20% for dividend income in 1997) on the grossed-up dividend (i.e. the cash dividend plus the ACT). Hence basic rate shareholders were deemed to have paid tax in full on any dividends received, and consequently did not have to pay any further tax. Higher rate taxpayers, whose marginal tax rate was 40%, had to pay additional tax. For a £100 cash dividend, they had to pay tax on the grossed-up value of £125, i.e. a total of £50, but they could offset against that the £25 tax credit, leaving them with another £25 to pay.

The crucial element of the tax regime for our purposes is that tax-exempt UK shareholders were entitled to claim a tax rebate equal to the ACT paid by the firm. Just before the tax reform in 1997, this was worth 25% of the cash dividend (equivalent to 20% of the grossed-up dividend). As noted earlier, the cost of paying this rebate prior to 1997 was around £5 billion per year, around 20% of UK corporation tax revenue.

The 1997 tax reform abolished this cash rebate for UK pension funds, and the pension-related assets of UK insurance companies. Other tax-exempt shareholders - charities, non-tax-paying individuals, and holders of tax-advantaged personal equity plans - were unaffected. Some tax treaties also provided for non-UK shareholders to receive part of the tax credit - worth approximately 6% of the cash dividend. They too were unaffected by the 1997 reform.

In 1999 the system was further reformed. The cash rebate was now abolished for most other non-tax-paying individuals,[8] including those foreign shareholders that used to receive some benefit.[9] The credit rate was halved to 10%, but UK

[8] Charities received temporary compensation for this loss. Holders of 'Individual Savings Accounts' continued to receive credits until 2004.

[9] For foreign shareholders this was achieved by halving the tax credit to 10% and applying a

tax-paying shareholders were unaffected, as income tax rates on dividend income were also reduced. At this time, ACT was also abolished, and new payment arrangements were introduced for companies paying corporation tax.

3 A Simple Portfolio Model

We present a simple version of the one period tax-adjusted CAPM model of Brennan (1970) which has been widely used to study the case of shareholders with heterogeneous tax rates.[10] The aim here is to identify the effects of differences in tax rates, not only across investors, but also across assets for an individual investor.

There are a large number, N, of investors. Investor i has an endowment of X_i, which is divided between two risky assets, H and W, and a risk-free asset. Investor i holds H_i shares at price p in asset H, W_i shares at price q in W, and the remainder, $B_i = X_i - pH_i - qW_i$, in the risk-free asset. Dividends from H and W, denoted D^H and D^W, are taxed at rates m_i^H and m_i^W respectively, net of any dividend tax credits. Capital gains are taxed at rate z_i for both assets. Interest income from the risk-free asset is taxed at rate m_i. Dividends are assumed to be known, but the prices of the risky assets at the end of the period, denoted $\widetilde{P}^H$ and $\widetilde{P}^W$, are stochastic. Random variables are denoted with a tilde - their expected values at the start of the period are shown without the tilde.

The end-of-period wealth of investor i is $\widetilde{Z}_i$, where

$$\begin{aligned}
\widetilde{Z}_i &= (1 + r(1 - m_i))B_i \\
&\quad + \left(\widetilde{P}^H + (1 - m_i^H)D^H - z_i\left(\widetilde{P}^H - p\right)\right)H_i \\
&\quad + \left(\widetilde{P}^W + (1 - m_i^W)D^W - z_i\left(\widetilde{P}^W - q\right)\right)W_i \\
&= X_i + (1 - z_i)\left\{\rho_i B_i + \left[\widetilde{G}^H + \gamma_i^H D^H\right]H_i + \left[\widetilde{G}^W + \gamma_i^W D^W\right]W_i\right\} \quad (1)
\end{aligned}$$

where $\widetilde{G}^i$ is the stochastic capital gain on asset i eg. $\widetilde{G}^H = \widetilde{P}^H - p$, where r is the

withholding tax of 10%, rather than by formally abolishing the credit.

[10] See, for example, Litzenberger and Ramaswamy (1979, 1980, 1982), Gordon and Bradford (1980), Auerbach (1983) and Michaely and Villa (1995).

risk-free interest rate,

$$\rho_i = \frac{(1-m_i)r}{(1-z_i)} \tag{2}$$

is the tax-adjusted discount rate of investor i, and

$$\gamma_i^H = \frac{(1-m_i^H)}{(1-z_i)} \text{ and } \gamma_i^W = \frac{(1-m_i^W)}{(1-z_i)} \tag{3}$$

are the tax discrimination variables of investor i for assets H and W respectively.

Investors choose H and W to maximise

$$V_i = Z_i - \frac{\varphi_i}{2} var(\widetilde{Z}_i) \tag{4}$$

where φ_i is a risk aversion parameter. The form of φ_i is important: we discuss two special cases below.

The expected value of $\widetilde{Z}_i$, denoted Z_i, is equal to the expression in (1), with the stochastic capital gains terms replaced by their expected values. The variance of $\widetilde{Z}_i$ is

$$var\left(\widetilde{Z}_i\right) = (1-z_i)^2\left(H_i^2\sigma_H^2 + W_i^2\sigma_W^2 + 2H_iW_i\sigma_{HW}\right) \tag{5}$$

where σ_H^2, and σ_w^2 are, respectively, the variances of $\widetilde{P}^H$ and $\widetilde{P}^W$, and σ_{HW} is the covariance.

Assuming an interior solution in which the investor simultaneously holds all three assets, the investor's demand for each asset can be derived from the first order conditions for H_i and W_i, which are:

$$\begin{aligned} H_i &= \frac{G^H + \gamma_i^H D^H - p\rho_i}{\varphi_i(1-z_i)\sigma_H^2} - \frac{W_i\sigma_{HW}}{\sigma_H^2} \\ \text{and } W_i &= \frac{G^W + \gamma_i^W D^W - q\rho_i}{\varphi_i(1-z_i)\sigma_W^2} - \frac{H_i\sigma_{HW}}{\sigma_W^2} \end{aligned} \tag{6}$$

We can use these demand equations to solve for the equilibrium prices, and rates of return. Suppose there are, in aggregate, H and W shares in the two risky assets respectively. Define $\lambda_i = 1/(1-z_i)\varphi_i$ so that a higher λ_i implies either lower risk aversion or a higher capital gains tax rate. Aggregating the first expression

for H_i over N investors and rearranging implies

$$\begin{aligned} H &= \sum_{i=1}^{N} H_i = \frac{G^H \sum \lambda_i + D^H \sum \lambda_i \gamma_i^H - p \sum \rho_i \lambda_i}{\sigma_H^2} - \frac{\sigma_{HW} W}{\sigma_H^2} \\ &= \frac{\sum \lambda_i \left[G^H + \overline{\gamma}^H D^H - p\overline{\rho} \right]}{\sigma_H^2} - \frac{\sigma_{HW} W}{\sigma_H^2} \end{aligned} \tag{7}$$

where $\overline{\gamma}^H$ and $\overline{p}$ are weighted averages:

$$\overline{\gamma}^H = \frac{\sum \gamma_i^H \lambda_i}{\sum \lambda_i} \tag{8}$$

$$\text{and } \overline{\rho} = \frac{\sum \rho_i \lambda_i}{\sum \lambda_i} \tag{9}$$

An equivalent expression holds for asset W. Alternatively, we can express the equilibrium expected return to purchasing a share in H, as

$$\frac{G^H + \overline{\gamma}^H D^H}{p} = \overline{\rho} + \frac{[\sigma_H^2 H + \sigma_{HW} W]}{p \sum \lambda_i}. \tag{10}$$

This takes a familiar form: the expected return is equal to the weighted average return on the risk-free asset, plus an adjustment for risk. The definition of the weighted average return is discussed below. The risk adjustment depends on the variance of the end-of-period price of the asset itself and the covariance with the end-of-period price of the other risky asset, where the weights on these two terms depend on their relative size in the overall market. If asset H is sufficiently small relative to W, then only the covariance term matters. This expression is consistent with Brennan's (1970) model of the CAPM with personal taxes and has been the subject of extensive empirical testing.[11]

The portfolio choice of investor i depends on his own tax rates relative to that of other investors. Specifically,

$$H_i = \frac{\lambda_i H}{\sum \lambda_i} + \frac{\lambda_i}{(\sigma_W^2 \sigma_H^2 - \sigma_{HW}^2)} \left\{ \begin{array}{c} (\gamma_i^H - \overline{\gamma}^H)\sigma_W^2 D^H - (\gamma_i^W - \overline{\gamma}^W)\sigma_{HW} D^W \\ -(\rho_i - \overline{\rho})(p\sigma_W^2 - q\sigma_{HW}) \end{array} \right\}. \tag{11}$$

Clearly, investor i will tend to hold more or less of H, depending on whether his tax parameter, γ_i^H is above or below the weighted average, $\overline{\gamma}^H$. If, for example,

[11] See, for example, Litzenberger and Ramaswamy (1979, 1980, 1982), Black and Scholes (1974), Miller and Scholes (1982), Kalay and Michaely (2000).

γ_i^H=1.25 and $\overline{\gamma}^H = 1$, as was broadly the case for UK pension funds holding UK equities before 1997, then pension funds would hold more of this asset. How much more depends on the risk of the two assets and the investor's risk aversion, λ_i. For example, the more risk averse is the investor (the lower λ_i), the less would be the tendency to have additional holdings of this asset in response to favorable tax treatment. Of course, the tax treatment of the other assets also affect the holdings of H. Advantageous tax treatment of the return from W or the risk-free asset relative to a weighted average of other investors (ie. $\gamma_i^W > \overline{\gamma}^W$ or $\rho_i > \overline{\rho}$) would reduce holdings of H by investor i.

To examine the effects of differential taxation further, it is necessary to examine the weighted average tax rates. It is useful to simplify by assuming that all investors face the same rate of capital gains tax on all assets, in which case the weighted averages depend only on the risk aversion parameter, φ_i:

$$\overline{\gamma}^H = \frac{\sum \gamma_i^H/\varphi_i}{\sum 1/\varphi_i} \quad \text{and } \overline{\rho} = \frac{\sum \rho_i/\varphi_i}{\sum 1/\varphi_i} \tag{12}$$

Now consider two special cases:

(i) all investors have the same degree of risk aversion: $\varphi_i = \varphi \quad$ for all i. In this case, $\sum \lambda_i = N/(1-z)\varphi$ and $\overline{\gamma}^H$ and $\overline{\rho}$ reduce to unweighted averages across all investors. One implication of this is that individual holdings of the risky assets do not depend on the initial endowment. Consider (11), but setting the tax rates faced by all investors on each asset to be the same. Then the second term is zero and $H_i = H/N$: all investors hold the same number of shares in H. Any difference in endowments is reflected only in the holding of the risk-free asset. Of course, holdings of the risky assets are affected by tax rates; but the fact that holdings differ across investors is not reflected in the construction of the average tax rates, which are unweighted. This is because each investor is at a margin and is equally likely to trade part of the the holding.

A simple alternative to this is:

(ii) risk aversion differs only across endowments: $\varphi_i = \varphi/X_i$.[12] In this case,

[12] Of course it is straighforward to allow for differences in preferences as well as endowments. For example, $\varphi_i = \theta_i/X_i$ where θ_i represents individual preferences.

the weights for $\overline{\gamma}^H$ and $\overline{\rho}$ are initial endowments:

$$\overline{\gamma}^H = \frac{\sum \gamma_i^H X_i}{\sum X_i} \text{ and } \overline{\rho} = \frac{\sum \rho_i X_i}{\sum X_i}. \tag{13}$$

This is more intuitive; abstracting from differences in taxes again, holdings of risky assets are exactly proportional to the endowment since $\lambda_i / \sum \lambda_i = X_i / \sum X_i$. Note though that again the weighted tax rates do *not* depend on the holdings of each asset: indeed, the weights for H and W are the same. Suppose investor i has a tax advantage from H and hence holds a greater proportion of his investment in H compared to other investors. It is not the case that the weighted average tax rate for H disproportionately reflects i's tax rate. As in the previous case, all investors are at the margin; the difference from the previous case is that since holdings are proportional to the endowment, then a wealthier investor would trade more in response to a change in, say, the expected end-of-period price. As a result, his tax rate is weighted more.

It is interesting to note the consequences of taxes varying only across investors, so that $m_i = m_i^H = m_i^W$ and hence $(\gamma_i^H - \overline{\gamma}^H) = (\gamma_i^W - \overline{\gamma}^W) = (\rho_i - \overline{\rho})$ for all investors. In this case, investor i would hold more or less than the weighted average $(\lambda_i H / \sum \lambda_i)$ holding, depending on whether he faced a relatively high tax rate (that is, whether $\gamma_i^H \gtrless \overline{\gamma}^H$), and on the sign of $\sigma_W^2 D^H - \sigma_{HW} D^W - (p\sigma_W^2 - q\sigma_{HW})$. Even in this case, it is therefore generally not true that all investors would divide their portfolio across assets in the same way. Hence the weights for constructing the average tax rates would still not be equal to relative holdings of the individual assets.

However, finally note that from (10), the market valuation of each asset depends only on the tax rates applied to that asset. An implication of this is that expression (10) is equally valid in considering the price implications of the recent US dividend tax reform, even though that tax reform applied to dividends from all equities. The US tax reform reduced the dividend tax rate for US personal investors. The effect of this on US equity prices depends on how the average tax rate across all investors in US equities was affected. If the group of US taxpayers affected was sufficiently small, relative to tax-exempt US investors and non-US investors, then again as a first approximation, there would be little or no impact

on US equity prices.[13]

We note three qualifications to this simple model. First, we have assumed an internal solution in which all investors hold all assets. Consider the introduction of a subsidy to a group of investors on the income from asset H. This will induce those investors to switch their holdings in favour of H. They will continue to do so either up to the point at which, at the margin, the gain from the subsidy is exactly offset by the additional risk they bear by moving away from an optimally diversified portfolio - this is characterized by (6) - or until those investors have switched all their holdings to asset H. In practice we do not observe investors holding only one form of asset, and so (6) seems the most likely equilibrium.

Second, as argued by Miller and Scholes (1978), it may be the case that trading costs deter some investors responding to small changes in the prices or expected returns from particular assets. If only a subset of all investors respond to new information, then at the margin, it is only the tax rates of those "marginal" investors which will be reflected in the weighted average tax rates. The relevance of this observation for examining the UK tax reform depends on whether the weight of UK pension funds should be higher than if all investors were taken into account. This is a key empirical issue which we address below.

Third, this model ignores trading around the ex-div day. To prevent a tax-favoured investor holding only asset H cum-div and then diversifying ex-div, it is necessary to introduce some cost to this trading strategy. For example, there may be transaction costs, or a risk of unfavorable underlying price movements around the ex-div day. Michaely and Villa (1995) develop a theoretical model in which ex-div day trading is allowed but is endogenously limited. Lasfer (1995) presents empirical evidence that ex-day returns in the UK are not significantly affected by short-term trading. We follow Bell and Jenkinson (2002) in assuming that an analysis of UK ex-day returns can in principle identify the impact of dividend taxation.

[13] Chetty, Saez and Rosenberg (2005) provide more detail on this US tax reform, and empirical evidence on its impact on US equity prices.

4 Empirical Implications

This model suggests two empirical hypotheses about the impact of dividend taxes.

First, the overall effect of dividend taxes on share prices reflects the weighted average tax rate of all investors, $\overline{\gamma}^H$. What does this suggest about the impact of the 1997 UK dividend tax reform on UK share prices? Even taking the second special case above, UK pension funds control only small proportion of the total wealth invested in all markets. Any change in their tax rate is therefore likely to have a negligible effect on UK equity prices. Thus:

Proposition 1 *The 1997 tax reform should have little or no effect on the prices of UK equities.*

We test this proposition below using the standard technique of analyzing drop-off ratios. When a share goes ex-dividend, marginal shareholders are indifferent between either selling the share at the cum-dividend price, thus forgoing the dividend, or keeping the share and thus receiving the dividend. Denote the cum-div price by P_c, the ex-div price by P_{ex}, and the dividend by D. Then following Elton and Gruber (1970), and using (10), we have

$$P_c - P_{ex} = \overline{\gamma} D \tag{14}$$

or

$$\frac{P_c - P_{ex}}{D} = \overline{\gamma}. \tag{15}$$

The term on the left hand side of this expression is the drop-off ratio (DOR): the fall in the price expressed as a proportion of the dividend. The term on the right hand side is the tax discrimination variable, described above. The DOR can therefore be used to estimate the average value of the tax discrimination parameter γ - which determines the share price.

In practice, we measure P_c at the end of trading on the last day the share trades cum-dividend, and P_{ex} at the end of trading on the first day the share trades ex-dividend. Clearly, the difference between these two prices will reflect not only the dividend payment, but all other news about the value of the firm that emerges on

the ex-div day. Averaging across a large number of independent observations on DORs is therefore required to obtain a useful estimate of $\overline{\gamma}$. Adjustments can also be made for market movements on ex-div days (see below).

For comparison with Bell and Jenkinson (2002), we follow the same approach as them in estimating $\overline{\gamma}$. Briefly, assume, following Lakonishok and Vermaelen (1983), that the price changes are random variables which can be written as

$$P_c - P_{ex} = \theta D + \epsilon \tag{16}$$

where the ϵ are independently distributed with

$$E(\epsilon) = 0 \quad \text{and} \quad var(\epsilon) = P_c^2 \sigma^2; \tag{17}$$

that is the standard deviation of the unexplained price change is assumed to be proportional to the share price. As proposed by Boyd and Jagannathan (1994), an efficient estimate of $\overline{\gamma}$, before and after the tax reform, can then be found by estimating

$$\frac{P_c - P_{ex}}{P_c} = \theta_1 \frac{D}{P_c} + \theta_2 F \frac{D}{P_c} + e \tag{18}$$

where

$$e = \frac{\epsilon}{P_c} \text{ and hence } var(e) = \sigma^2. \tag{19}$$

In (18), θ_1 provides an estimate of $\overline{\gamma}$ prior to the tax reform. F is a dummy variable which takes the value of 0 for observations before the tax reform and 1 for observations after the tax reform; hence θ_2 is an estimate of the change in $\overline{\gamma}$ following the tax reform. Based on microstructure models developed by Boyd and Jagannathan (1994) and Frank and Jagannathan (1998), which suggest a negative intercept in such a regression, a constant term may also be included.

A further common adjustment is to account for market movements on the ex-div day multiplied by a historic estimate of the correlation between the return on the share and the return on the market. That is, we replace P_{ex} with $P_{ex}^* = P_{ex} - P_c \beta R^m$ where R^m is the return on the market on the ex-day, and β is the CAPM measure of risk of that equity.

The second empirical prediction concerns holdings of UK equities. Expression (11) makes clear that, ceteris paribus, any investor will tend to hold more of a

given asset - say H - when his tax discrimination variable for that asset (γ_i^H) is above the average of all investors ($\overline{\gamma}^H$). As is clear from the discussion above, until 1997 the value of γ for UK pension funds holding UK equities was 1.25 and therefore significantly above the average value across all investors. However, after 1997, this value fell to 1. This implies that:

Proposition 2 *UK pension funds should hold a disproportionately high share of UK equities before 1997, but this share should fall after 1997. By contrast, other investors should hold a disproportionately low share of UK equities before 1997, but should increase their share after 1997.*

To investigate this proposition, we report evidence on the composition of equity portfolios before and after 1997 for UK pension funds and other institutional investors, and we report evidence on the share of UK equities held by different classes of investors.

5 Data

We set up our data to mirror as closely as possible the data used by Bell and Jenkinson (2002), to ensure that any differences we encounter are not caused by the samples.

Specifically, we use data from Thomson Financial Datastream on dividend payments of quoted UK companies. This data set contains one observation per payment, i.e. typically two observations per firm per year, as most UK firms pay an interim and a final dividend in each accounting year. We merge daily data on share prices and return indices into this data set, keeping in each case the observation on the day when the share first trades ex-dividend and on the day before, i.e. the ex-dividend and cum-dividend prices.

Before running regressions, we clean the resulting data sets as follows. We drop any observations where core data are missing, such as the payment date, the ex-dividend date, the (cum- or ex-dividend) share price or the value of the dividend. We also drop observations where the last cum-dividend observation predates the ex-dividend observation by more than 5 trading days. We drop a few

observations for which we cannot work out the accounting year end date, because we need this in order to match the dividend payment data with information from company accounts. After matching the data with company accounts, we drop all firms for which the sum of individual dividend payments over the year does not match up with the total dividend payment reported in the accounts. Then we drop all dividend payments that were designated as Foreign Income Dividends, as the tax treatment for this form of dividends was different. We also drop any observation for which the share price did not move on the ex-dividend date, which suggests that there was no trading. Finally we drop outliers, which we define as DORs in excess of 5.

As explained above, we adjust returns for general market movements using the CAPM. To allow comparisons with BJ, we follow their approach in estimating the correlation of each share's monthly returns with market returns (β). We thus run separate regressions of each share's monthly return (including capital gains and dividends) on the monthly return of the FTSE All-Share index during the 5 years preceding the tax reform. We only keep shares with at least 36 historical observations.

The cleaning procedure used by BJ is virtually the same as ours, except that they did not delete data where the sum of dividend payments differed from the figure reported in company accounts, and they did not drop outliers as defined above. Hence our sample is slightly smaller than theirs, with data on 7966 dividend payments by 1275 firms.

6 Results

This section first presents empirical evidence on the behavior of drop-off ratios in the UK. It then briefly considers evidence on UK equity ownership. Bell and Jenkinson (2002), henceforth BJ, use the 1997 reform to test whether taxes affect the valuation of dividends and to attempt to find the identity of what they refer to as "the" marginal shareholder. We first replicate their main findings using our sample, confirming that the mean drop-off ratio did fall significantly in the UK in the late 1990s. We then look in more detail at the nature and timing of this

change in the distribution of drop-off ratios, and consider fluctuations in the mean drop-off ratio over a longer horizon.

6.1 Bell and Jenkinson (2002) replication

Table 1 presents the results obtained from estimating mean drop-off ratios for pre-reform and post-reform periods in a similar way to BJ, based on OLS estimation of equation (18). Columns 1 and 2 reproduce the results from BJ; columns 3 and 4 present our replications. Like BJ, we compare the 30 month period before the 1997 tax reform with the 30 month period after the reform. Following BJ, we report results for the sample of all firms and for the sub-sample of the largest 250 firms. Our results are very similar to those obtained by BJ. While we estimate a smaller fall than BJ, we confirm that there was a significant fall in the mean drop-off ratio in the UK after July 1997, particularly for larger firms.

We implemented a number of robustness checks, which suggested that these results are robust. Specifically, we considered the following alternative specifications. (a) Including a constant term to allow for certain ex-dividend day trading behavior as suggested by microstructure models in Boyd and Jagannathan (1994) and Frank and Jagannathan (1998): this does not affect the estimated coefficients. (b) Not correcting the ex-div price (P_{ex}) for market movements: this hardly affects the coefficients and leads to slightly more significant falls in the mean DORs. (c) Not dealing with heteroskedasticity, i.e. just regressing the DOR on a constant and a post reform dummy: this does not affect the results for the sample of large firms. For the full sample, this reduces the estimated fall in the mean DOR by half. The estimated fall in this case is only significant at the 13% level.

Before extending the investigation, it is worth discussing the interpretation of these results. It is true that the estimated *change* in the mean DOR, at least for the larger companies, is close to the theoretical drop in the value of γ for UK pension funds: 20% (BJ) or 17% (our results) as against 20% in theory. However, if pension funds were "the" marginal shareholders, then the estimated *levels* of these mean DORs are not as expected. If pension funds were the marginal shareholders, the mean DOR should be around 1.25 before the reform and 1 after the reform.

For the largest firms, the empirical results suggest a mean DOR of around 1 before the reform and around 0.8 after the reform.

Of course, based on the asset pricing model set out in Section 3, we would not expect the mean DOR to reflect only the tax rates of UK pension funds, but rather an average across all investors in UK equities. While the levels of the mean DORs before and after the reform could reflect an average across investors, from this perspective, the significant fall in the mean DOR is more surprising.

6.2 Drop-off ratios and dividend yields

BJ also consider changes in the mean DOR for sub-samples divided by dividend yields. The 1997 tax reform affected those shareholders with the highest valuation of UK company dividends. In the presence of clientele effects, highly taxed investors would be expected to hold shares in low-dividend-paying firms, and lightly taxed (or subsidized) investors would be expected to hold shares in high-dividend-paying firms. This suggests that, before 1997, UK pension funds were more likely to be "the" marginal shareholders for UK firms with relatively high dividend yields. If this were the case, then the 1997 reform is expected to have most impact on the mean DOR for high-dividend-paying firms.

BJ report results that appear to support such clientele effects. Specifically they use annual data on dividend yields to divide their observations in the pre-reform and post-reform periods, separately, into quintiles. They then compare the mean drop-off ratio for each quintile in the pre-reform period with the mean drop-off ratio for the corresponding quintile in the post-reform period. We replicate these results in Table 2.[14] Like BJ, we find that the mean DOR fell significantly only when comparing observations with relatively high dividend yields, although it is not the case that observations in the top quintile had the largest or most significant drop.

Given that the rationale for splitting the sample by dividend yields is based on the tax preference of UK pension funds for a high dividend yield in the pre-reform

[14] Unlike BJ, we present results based on individual dividend payments, rather than artificial portfolios made up of all dividend payments on the same day. BJ state that results were similar in both cases.

period, it would seem more appropriate to divide the full sample into quintiles based on dividend yields in the pre-reform period only. We use data on average dividend yields in the pre-reform period to divide our sample of firms into quintiles. We then compare the mean drop-off ratio for each quintile in the pre-reform period with the mean drop-off ratio for the same sub-sample in the post-reform period. Unlike the procedure used by BJ, this ensures that we are comparing mean drop-off ratios *for the same firms* in the two sub-periods.

Table 3 presents these results. When the samples are classified in this way, it is notable that the fall in the mean drop-off ratio becomes small and statistically insignificant for the sub-sample with the highest dividend yields in the pre-reform period. The clear pattern in the behavior of drop-off ratios by dividend yields reported by BJ is thus quite sensitive to the precise way in which their sub-samples were chosen. Moreover, and regardless of the method used to select the sub-samples, we can note that the pattern of estimated mean drop-off ratios in the pre-reform period provides little support for the view that the tax treatment of UK pension funds was particularly important for the stock market valuation of UK firms with relatively high dividend yields.[15]

6.3 Evidence on the distribution of DORs

To investigate the behavior of DORs further, we now consider the distribution of DORs. The 1997 tax reform reduced the tax discrimination parameter γ_i for the class of shareholders which previously had the highest valuation of dividends. If UK pension funds were indeed "the" marginal investors for certain types of UK firms, the fall in the mean DOR reported in Table 1 should be associated with compression in the upper part of the distribution of DORs. Essentially, the highest values of γ_i were eliminated by the tax reform, while lower values of γ_i were unaffected.

To examine this prediction, Figure 2 plots various quantiles of the distribution of DORs over the same sample period used in Table 1. In fact we see the opposite pattern, with the fall in the mean DOR after 1997 being associated with a fall in

[15] Consistent with this, we find that the simple correlation coefficient between the DOR and the dividend yield in the pre-reform period is less than 1%.

drop-off ratios at the bottom end of the distribution. The upper quartile *increases* from 1.3 in 1995 to 1.4 in 1999, with no sign of any reduction following the 1997 tax reform. In contrast, the bottom decile falls steadily throughout this period, from 0.1 in 1995 to -0.6 in 1999. This indicates that there was a considerable increase in the proportion of observations with negative drop-off ratios. A negative drop-off ratio is found when the firm's share price increases (relative to the market) on the ex-dividend day, notwithstanding the loss of the entitlement to the dividend payment. We discuss this development further below, but note that shifts at the bottom end of the distribution of DORs are not easily explained by the change in the tax treatment of UK pension funds. More generally, Figure 3 shows that the distribution of DORs widened after 1997, while differences in the tax treatment of different classes of investors were reduced. This suggests that developments other than the 1997 tax reform may have been the dominant influence on the behavior of UK drop-off ratios during this period.

6.4 Further evidence on timing

We now extend the analysis to consider more carefully the timing of these changes in the mean drop-off ratio, and the longer term evidence. Following BJ, our regression analysis in Tables 1-3 neglected precise timing issues, as there was just one post-reform dummy: the test compared a 30 month period before the reform with a 30 month period after the reform. In order to see more precisely when the fall in the mean DOR occurred, we can estimate the mean DOR for 6 month and 12 month periods. To maintain comparability with the previous results, we again use the GLS estimation procedure explained in Section 4. Table 4 presents these estimates of mean DORs for each year and half-year from 1995 to 1999.

The annual estimates suggest that the mean DOR did not fall significantly until 1999, although the tax reform was implemented in July 1997. The six monthly estimates suggest that there was a marked fall in the second half of 1997. However they also show that there was a larger increase in the mean DOR in the second half of 1998, which stops this showing up in the annual estimate for 1998. Indeed the mean DOR in the second half of 1998 is the highest found for any of these

six-month periods. This indicates that there are substantial fluctuations in these estimates of mean DORs, which may have little to do with tax changes.

To explore this further, we consider longer term evidence. Figure 2 plots annual and six-monthly estimates of mean DORs between 1988 and 2000.[16] Our original sample period is marked here by the two vertical bars, with the tax reform occurring in the middle of that period.

This evidence confirms that the behavior of the mean DOR in the UK is indeed erratic. There is a sharp increase from 1988 to 1991, which is not explained by any change in the tax treatment of UK pension funds. Both the fraction of equity owned by tax-exempt institutions (see below) and their tax treatment were stable over this period. The tax discrimination parameter γ for UK pension funds fell from 1.33 in 1992 to 1.25 in 1994, when the rate of the refundable dividend tax credit was reduced from 25% to 20%. However we see that there was no fall in the mean drop-off ratio for UK companies over this period. The period studied by BJ is thus unique in showing an association between a significant fall in the mean DOR and an increase in dividend taxation for UK pension funds. Furthermore, the mean DOR at the end of this period, in the second half of 2000, is very similar to that at the start of the period, in the first half of 1988, although the relevant tax discrimination parameter for UK pension funds had fallen from 1.33 to 1.

These fluctuations in the mean drop-off ratio appear to be associated with changes at the bottom end of the distribution, and in particular with the fraction of observations where the drop-off ratio is negative. Table 5 reports annual figures for the share of observations with negative drop-off ratios. This fraction falls sharply from 1988 to 1991 and increases sharply towards the end of the 1990s, mirroring the fluctuations in the mean drop-off ratio shown in Figure 2. Negative values for the drop-off ratio - observations where the share price increases despite the share going ex-dividend - seem to be most common in periods when the stock market is both volatile and rising. This was the case immediately after the 1987 stock market crash, and again during the dot com bubble period of the late 1990s. These developments in the tail of the distribution of drop-off ratios appear to exert

[16] Unfortunately we do not have the required data on dividend payments to calculate DORs before 1988.

a strong influence on the behavior of the estimated mean.

The behavior of the mean drop-off ratio in the US provides further grounds for doubting whether the fall in the UK emphasized by BJ was related to the 1997 UK dividend tax reform. Estimates presented in Chetty, Rosenberg and Saez (2005) show that the mean DOR in the US also fell sharply over the period studied by BJ, from around 0.8 in 1994 to around 0.4 in 2000, with the sharpest fall also occurring from 1999 to 2000. Using data over the period 1963-2004, Chetty, Rosenberg and Saez show that such fluctuations in the mean DOR in the US are not uncommon, and display little relationship with changes in dividend taxation. Our evidence for the UK supports their conclusion: estimates of mean drop-off ratios are too volatile to provide reliable evidence about the impact of dividend taxes on the stock market valuation of firms.

6.5 Equity ownership

The second proposition discussed in Section 4 concerned the share of UK equities in the portfolios of UK pension funds. This share is expected to fall after the July 1997 tax reform eliminated a major tax advantage for UK pension funds of dividends from UK companies. This prediction also applies to the holdings of UK insurance companies insofar as they relate to the provision of pension plans, although not to the provision of life insurance.

Table 6 reports the proportion of UK equities in the total equity holdings of UK pension funds, insurance companies and unit trusts between 1990 and 2001. The UK share of pension fund equity portfolios did indeed fall sharply, from around three quarters at the end of 1996 to around two thirds by the end of 2001, having been quite stable during the first half of the 1990s. The UK share of insurance company equity portfolios also fell, from around 80% to around 75%, having also been stable in the period before this tax reform. In contrast, for unit trusts - mutual funds whose tax treatment did not change at all in 1997 - there was a temporary *increase* in the UK share of their equity holdings immediately after the tax reform, although this has since returned to its pre-reform level. This indicates that the change in the composition of equity portfolios observed for UK pension

providers was not common to all UK institutional investors during this period. The smaller fall for insurance companies relative to pension funds is consistent with the tax change affecting only part of insurance company portfolios.

Table 7 reports estimates of the fraction of total UK quoted equity owned by different types of shareholders, for the years between 1990 and 2000 for which these estimates are available. The last observation before the July 1997 tax reform refers to the end of 1994, when UK pension funds owned 28% of equity quoted on the London stock exchange. This share fell to 18% by the end of 2000, although it is not possible to date precisely the timing of this fall. The share owned by UK insurance companies has been much more stable. This suggests that the fall in UK equity as a share of insurance company total equity holdings, shown in Table 6, reflected an increase in the total size of their portfolios rather than a fall in their holdings of UK equity. The fall in the share of UK equity owned by UK pension funds was accompanied by an increase in the share of UK equity owned by foreign shareholders, which rose from 16% at the end of 1994 to 32% by the end of 2000. While this was partly a continuation of a longer term trend, it seems likely that this increase in foreign ownership of UK equity was given further impetus by the reduced attractiveness of UK equity to UK pension funds after the abolition of refundable dividend tax credits in July 1997.

As we discussed in Section 3, the effect on the valuation of UK equities would depend on the size of the premium required by foreign investors to increase their exposure to UK-specific risks. A negligible change in this risk premium is consistent with the absence of any noticeable effect on the level of the UK stock market (Figure 1). At first sight this is inconsistent with the change in the mean drop-off ratio after 1997 emphasized by BJ, but as discussed earlier in this section, there are reasonable grounds for doubting whether this fall in the mean drop-off ratio was driven by the change in the tax treatment of UK pension providers.

7 Conclusions

This paper explores the extent to which dividend taxes are capitalised into share prices, using information derived from a significant UK tax reform. When different

investors are subject to different tax rates, the Capital Asset Pricing Model suggests that the market valuation of equity should depend on an average of tax rates across all investors. In the context of the UK, the model suggests that all investors that hold both UK equities and other assets are marginal, with differences in tax treatments just offset by differences in exposure to risks at the optimal portfolio allocations. Moreover, since the wealth invested by UK pension providers is small relative to the size of the world capital market, as a first approximation we would expect a change in the tax treatment of UK pension funds to have little or no effect on the pricing of UK equities. The first-order effects of this tax reform should instead be seen in a shift in the composition of pension providers' portfolios away from UK equities. This affects equity prices only to the extent that other investors - notably foreign investors - require a higher risk premium to take up additional holdings of UK equity.

The abolition of refundable dividend tax credits in July 1997 represented a substantial increase in the taxation of dividends paid by UK companies to UK pension funds and UK insurance companies providing pension plans. Bell and Jenkinson (2002) argued that this tax reform had a substantial impact on the stock market valuation of dividends paid by UK firms, implying that UK pension providers were 'the' marginal investors in UK equity, at least in the period before the tax reform. However, we question this conclusion, which is not consistent with the CAPM We confirm that there was a fall in the mean drop-off rate after 1997, but question whether it can confidently be attributed to the abolition of refundable dividend tax credits for UK pension funds. The largest fall occurred in 1999, some eighteen months after the tax reform. While the tax change affected investors with the highest valuation of UK dividends, the main change occurred in the lower tail of the distribution of drop-off ratios. As in the US, the mean drop-off ratio in the UK is shown to fluctuate erratically over a longer time period. Indeed the period studied by Bell and Jenkinson (2002) appears to be unique in showing an association with changes to the tax treatment of UK pension funds. Interestingly, Chetty, Rosenberg and Saez (2005) have shown that there was also a sharp fall in the mean drop-off ratio in the US in late 1990s. Presumably this

fall in the US was not driven by the tax treatment of UK pension funds; though it may have been driven by factors that were common to the US and the UK stock markets during this dot com bubble period.

We share the skepticism of Chetty, Rosenberg and Saez (2005) about the use of mean drop-off ratios to test hypotheses about the impact of dividend taxation. Mean drop-off ratios are simply too volatile to attach causal significance to short-run fluctuations around tax reforms.

We report evidence on the ownership of UK equities that are consistent with the predicted changes to the composition of UK pension fund portfolios after this tax reform in 1997. UK pension funds have reduced their exposure to UK-specific risks following the abolition of a uniquely favorable tax treatment of UK dividends. Foreign shareholders have increased their holdings of UK equities over the same period. Noting the relative size of UK and foreign investors, asset pricing theory does not suggest that this should have had a major impact on the market valuation of UK equity. This is consistent with the absence of a crash in the UK stock market on the announcement of this tax reform; and, in our view, it is also consistent with a closer examination of the available empirical evidence.

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Table 1: Regression results obtained by BJ and replication

	BJ all firms	*BJ largest 250*	*Replication all firms*	*Replication largest 250*
Observations	8837	2348	7966	1565
pre 07/97	0.890**	1.028**	0.904**	0.978**
	(0.018)	(0.027)	(0.013)	(0.024)
Δ post 07/97	-0.106**	-0.204**	-0.080**	-0.168**
	(0.029)	(0.041)	(0.024)	(0.050)

Notes: Heteroskedasticity-robust standard errors in parentheses. Results obtained by regressing DORs multiplied by D/P_c on D/P_c, and a post-reform dummy multiplied by D/P_c. Stars indicate the level of significance (*: 10%, **: 5%).

Table 2: Regression results by dividend yield quintiles

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Observations	1594	1593	1594	1593	1592
pre 07/97	0.821	0.834	0.912	0.927	0.917
	(0.050)**	(0.033)**	(0.028)**	(0.025)**	(0.023)**
Δ post 07/97	-0.021	0.007	-0.114	-0.114	-0.078
	(0.086)	(0.053)	(0.051)**	(0.040)**	(0.043)*

Notes: Heteroskedasticity-robust standard errors in parentheses. Results obtained by regressing DORs multiplied by D/P_c on D/P_c, and a post-reform dummy multiplied by D/P_c. Sample split by dividend yield quintiles before and after reform, where *(5)* is the top quintile. Stars indicate the level of significance (*: 10%, **: 5%).

Table 3: Regression results by pre-reform dividend yield quintiles

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Observations	1387	1649	1633	1598	1525
pre 07/97	0.765	0.859	0.908	0.935	0.910
	(0.058)**	(0.035)**	(0.025)**	(0.025)**	(0.023)**
Δ post 07/97	0.014	-0.041	-0.086	-0.122	-0.032
	(0.081)	(0.057)	(0.040)**	(0.046)**	(0.044)

Notes: Heteroskedasticity-robust standard errors in parentheses. Results obtained by regressing DORs multiplied by D/P_c on D/P_c, and a post-reform dummy multiplied by D/P_c. Sample split by pre-reform dividend yield quintiles, where *(5)* is the top quintile. Stars indicate the level of significance (*: 10%, **: 5%).

Table 4: Estimated drop-off ratios by year / half-year

Half year	*Yearly*	*Half-yearly*
1995h1		.92
	.91	(.02)
1995h2	(.02)	.88
		(.03)
1996h1		.87
	.89	(.03)
1996h2	(.02)	.91
		(.03)
1997h1		.92
	.89	(.03)
1997h2	(.02)	.84
		(.04)
1998h1		.80
	.88	(.04)
1998h2	(.03)	.95
		(.04)
1999h1		.77
	.76	(.06)
1999h2	(.04)	.76
		(.04)

Notes: Heteroskedasticity-robust standard errors in parentheses. Results obtained by regressing DORs multiplied by D/Pc on D/Pc for each year and half-year using the full sample of firms.

Table 5: Share of negative DORs

Year	*88*	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*96*	*97*	*98*	*99*	*00*
Share of negative DORs (%)	21	14	13	9	15	12	12	9	10	13	15	16	20

Notes: Calculated for full sample of firms.

Table 6: Share of UK equities in total equity holdings of pension funds, long-term insurance companies and unit trusts

	Pension Funds	*Insurance Companies*	*Unit trusts*
1990	75.0%	80.9%	64.9%
1991	74.2%	79.6%	62.0%
1992	76.2%	80.3%	60.4%
1993	74.9%	78.2%	60.1%
1994	74.6%	77.9%	56.4%
1995	75.7%	77.7%	62.1%
1996	76.6%	79.0%	58.8%
1997	76.5%	80.5%	66.9%
1998	75.5%	80.6%	64.6%
1999	70.7%	76.7%	63.0%
2000	68.8%	78.6%	59.5%
2001	67.1%	75.1%	59.2%

Source: Financial Statistics, tables 5.1A and 5.1B.

Table 7: Beneficial Ownership of UK equities

	1990	*1991*	*1992*	*1993*	*1994*	*1997*	*1998*	*1999*	*2000*
UK Pension Funds	31.7	31.3	32.4	31.7	27.8	22.1	21.7	19.6	17.7
UK Insurance Companies	20.4	20.8	19.5	20	21.9	23.5	21.6	21.6	21.0
Foreign Shareholders	11.8	12.8	13.1	16.3	16.3	24	27.6	29.3	32.4

Source: National Statistics (2003), table A; end of year figures. No data available for 1995 and 1996.

Figure 1: FTSE 100 index, 2nd of July 1997 indicated by vertical line. Source: Thomson Financial Datastream

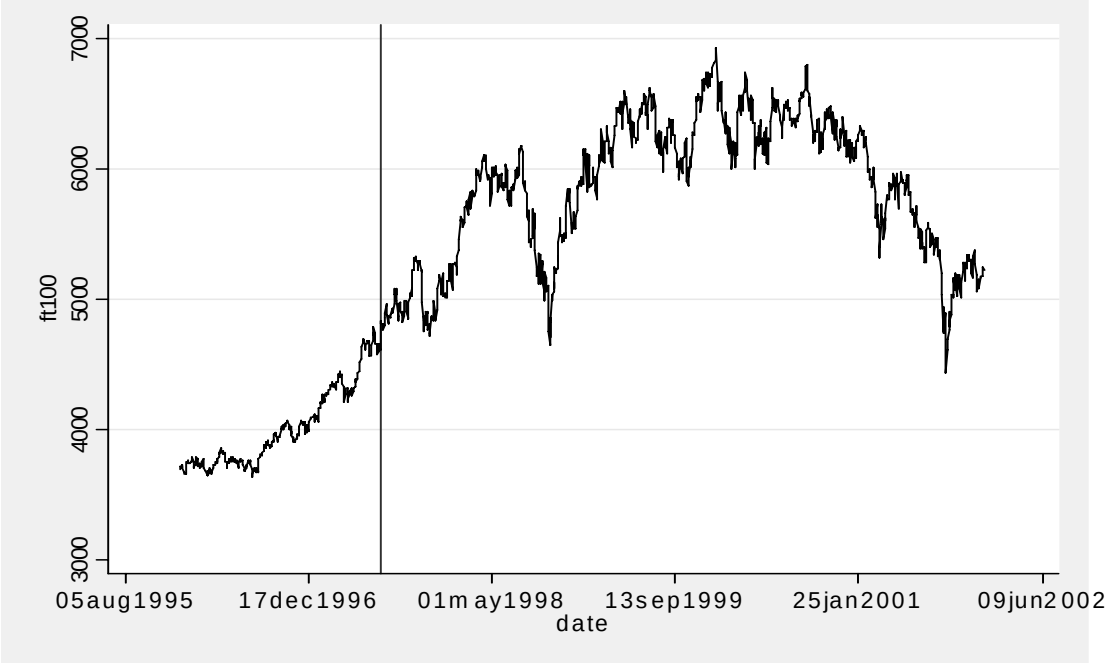


Figure 2: The distribution of estimated DORs

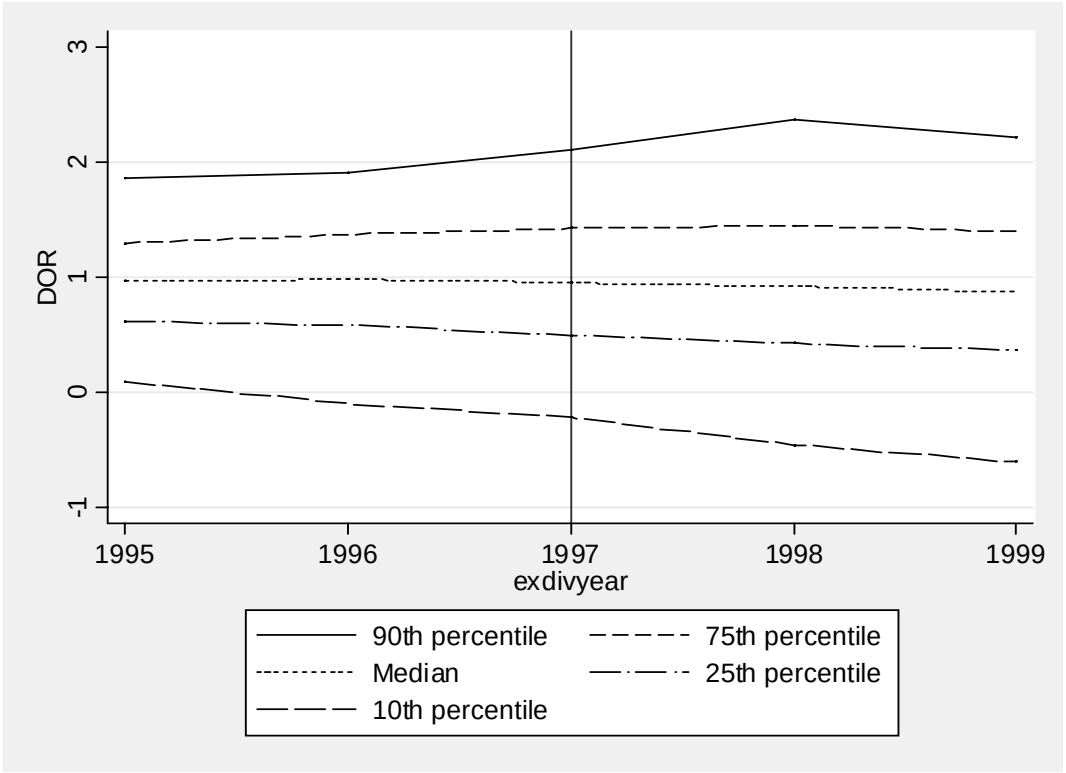
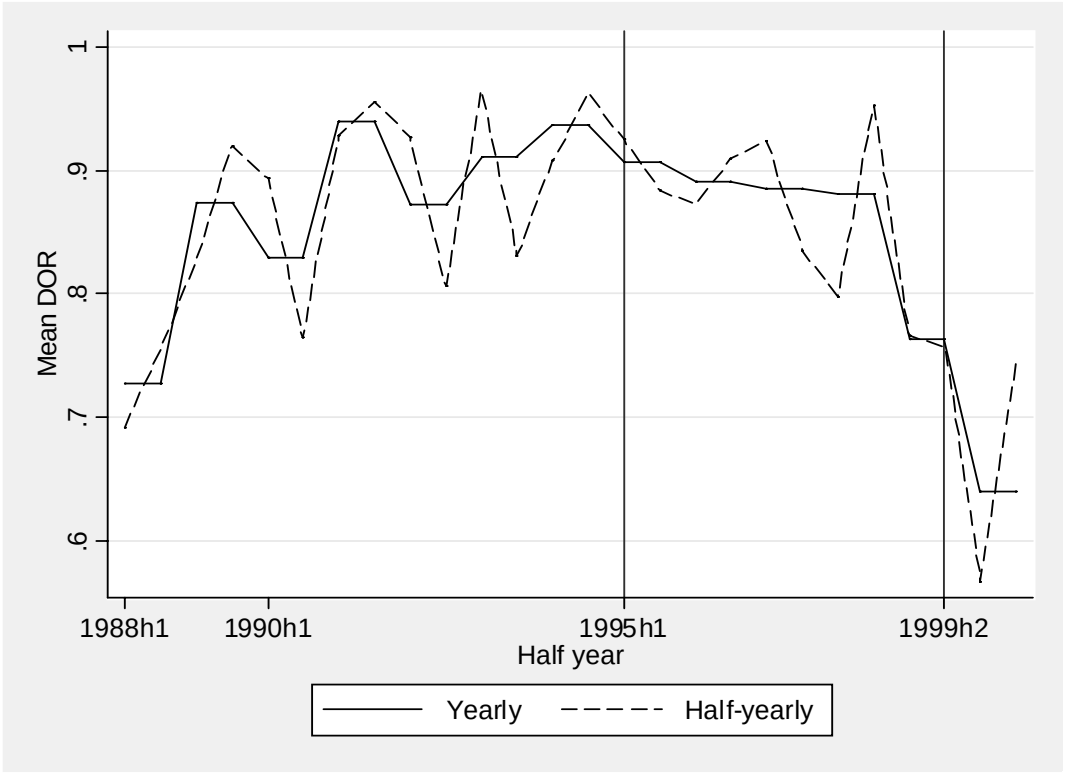


Figure 3: DORs from 1988 to 2000



Notes: Results obtained by regressing DORs multiplied by D/P_c on D/P_c for each year and half-year using the full sample of firms.

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