Ex-Dividend Day Pricing in Portugal: Recent Evidence

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ABSTRACT

Our study assesses the ex-dividend stock price behavior in the Portuguese stock exchange, between 2004 and 2017. The most striking captivating characteristic of this period is the fact that, from 2012 onwards, dividends and capital gains taxes were the same for private investors. This allowed us to conduct an analysis of the impact of these tax changes on ex-dividend price formation. Using panel data regression methods, we analyzed a sample of 262 observations from 23 listed firms. For our full sample period, we find, as expected, a positive relationship between the dividend yield and ex-dividend price change, i.e., the ex-day price fall is related to the gross dividend amount. At first, when testing for a tax explanation in the formation of ex-dividend prices, our results were not robust enough to support the hypothesis. Nonetheless, after splitting the sample into the period before and after the 2012 tax change and comparing both subsamples, we find evidence that points towards the presence of a tax effect. We find no evidence supporting market microstructure arguments in ex-dividend price behavior. We tested our first subsample (before the tax changes) for clientele effects, and the observed results were insignificant.

Keywords: Dividend Policy, Capital Markets, Market Efficiency, Taxation
JEL Codes: G10, G12, G14

I. Introduction

In a perfect market, where taxes do not exist and all market participants are rational, the stock price should fall by the full amount of the gross dividend on the ex-dividend day.[1] However, a number of empirical studies spanning across the past several decades have shown that, generally, stock prices do fall on the ex-day, but by less than the full dividend amount.

Our contribution to the discussion is in line with that of Farinha and Sôro (2006) and Borges (2008), who looked at the ex-dividend price behavior in the Portuguese stock market. Interestingly, they came to opposite conclusions, with Farinha and Sôro (2006) finding evidence supporting Elton and Gruber's (1970) tax explanation, while Borges (2008) argues against the validity of that reasoning. We aim to add to the ex-dividend

[1] The first day that a given stock trades without the right to receive a dividend associated to it.

pricing debate in general, but also to extend the work carried out in relation to the Portuguese stock market in general. In addition, our sample period is unique when it comes to studies concerned with ex-dividend price behavior in Portugal. In 2012, Portugal moved from a taxation scenario favoring capital gains over dividends, as is more common in the literature, to one of equal taxation, i.e., tax indifference. We believe that it is this opportunity to study the same market during periods of different taxation, including one of indifference, that distinguishes the value of our study, allowing for a more powerful test of tax effects. With these tax changes as the foundation of our research, we follow Elton and Gruber's (1970) methodology and aim to access the presence of tax effects in the formation of ex-dividend prices in Portugal.

Like most studies, we find evidence of a positive relationship between the price change and the dividend yield. Moreover, we do not find strong enough evidence to support the existence of a clientele effect. Our results also do not corroborate the influence of microstructure effects on the formation of ex-dividend prices, as suggested by Bali and Hite (1998) and Boyd and Jagannathan (1994). Our most striking results concern the tax explanation. We first test the sample as a whole and find that our results are not strong enough to support the presence of a tax effect. However, after splitting the sample into two, considering the periods before and after the 2012 tax changes, we see that the difference and the results obtained for each subsample do point towards a tax explanation.

Our paper is organized in the following way: the next section is a brief review of the existing empirical work on this topic. Section III provides an overview of the Portuguese tax system and, critically, the changes that occurred in 2012. In section IV, we state our research hypotheses and describe our methodological approach as well as our sample. We present our results in section V, and section VI concludes our work.

II. Literature review

It was Farrar and Selwyn (1967) who first looked at the differential tax treatment between dividends and capital gains and how it relates to dividend payments. Using a partial equilibrium model, they find that, in the more common scenario of dividends being more heavily taxed than capital gains, firms should not distribute dividends, as investors would prefer the better after-tax income offered by capital gains. With this study as a basis, Brennan (1970) develops a market equilibrium model and concludes that, in order to compensate for the tax disadvantage, investors will demand a higher before-tax dividend return.

While studying Miller and Modigliani's (1961) clientele effect hypothesis, Elton and Gruber (1970) established a relationship between the stock price behavior on the ex-dividend day and the taxation faced by the marginal investor. They developed a model that relates the dividend and capital gains tax rates to the ex-dividend price change ratio, i.e., the price change divided by the gross dividend amount. With this model, they showed that the ex-dividend price change should mirror the after-tax value of the dividend relative to the after-tax value of capital gains. Consequently, if the dividend tax is higher than the capital gains tax, the stock price should fall by less than the dividend. The authors find evidence of a tax effect in ex-dividend price formation and obtain results supportive of the clientele hypothesis. Since then, Elton and Gruber's (1970) arguments have been extensively evaluated in the literature.

A contribution worth mentioning, which supports Elton and Gruber (1970), is the study by Barclay (1987). This study examines the ex-dividend day behavior of common stock prices before the enactment of the federal income tax. On ex-dividend days during the pre-tax period, stock prices fell, on average, by the full amount of the dividend. Barclay's (1987) findings support the hypothesis that investors in the pre-tax period see capital gains and dividends as perfect substitutes as well as the theory that the differential taxation of dividends and capital gains has led to investors discounting the value of cash dividends relative to capital gains.

Kalay (1982) challenges Elton and Gruber's (1970) findings, arguing in favor of short-term arbitrage as the main driver behind ex-dividend prices. While acknowledging that taxes influence investor decisions, the author shows that the marginal tax rate cannot be inferred from the relationship between ex-dividend price behavior and the dividend yield without any additional information. Kalay (1982) states that the ex-dividend price fall cannot be explained by a tax effect, but rather by the transaction costs faced by arbitrageurs.

A different challenge to Elton and Gruber's (1970) work is based on that of the market microstructure arguments. Frank and Jagannathan (1998) find that, in Hong Kong, where there are no dividends or capital gains taxes prices fall by less than the dividend on the ex-day. They also state that handling dividends, i.e., collecting dividend payments and possibly reinvesting them, is troublesome for private investors but not for large, market-making investors. They argue that market makers buy at the ask price before the stock ex-dividend date and sell it at the bid price after the ex-dividend date. Frank and Jagannathan (1998) say that even in the absence of taxes this would mean that prices would fall on the ex-day. Another study that falls under the scope of microstructure arguments is the one by Bali and Hite (1998) where the authors profess that the price drop around the ex-dividend day is less than the full amount of the dividend, but that it will stay within one tick of the dividend. It is worth noting that one of their important findings is that stock dividends, which are not taxable, show similar behavior in terms of price drop to cash dividends, which are taxable.

Several authors also applied Elton and Gruber's (1970) ideas to periods where changes in taxation took place. One such paper is by Michaely (1991). The author looks at the behavior of ex-dividend stock prices around the time of the 1986 tax reform in the United States. At the time, this reform started by reducing and, eventually, later eliminated the differential treatment in terms of taxation between dividends and realized capital gains. Michaely (1991) finds that these tax changes did not have an impact on the ex-dividend price behavior, which leads him to the argument that individual investors oriented towards the long-term have no effect on ex-dividend prices. In addition, the author finds that these prices are mostly influenced by short-term traders and corporate traders. Zhang *et al.* (2008) examine the topic of ex-dividend pricing from a similar perspective. In 2003, the American taxation regime changed so that dividends and capital gains were henceforth taxed in the same way. The authors study how this affected ex-dividend pricing, and find that the price is affected by risk, transaction costs and taxes. In addition, they find that dividend clienteles weaken decreased with the tax change and the price drop ratio also decreased with the tax change. The abnormal trading volume of high dividend yield stocks around the ex-dividend day decreases with the tax cut, which would suggest that the tax cut reduced the reason behind tax-induced trading.

There are also several studies that were conducted outside of the US market. Booth and Johnston (1984) use the ex-dividend day price drop and the associated dividend to try to measure the market's marginal tax rate, i.e., an implied tax rate, which Elton and Gruber (1970) first suggested. The sample used is from the 1970-80 Canadian stock market, an interesting period given that four different tax changes took place. The authors find little evidence of clientele effect and conclude as well that arbitrage fails to explain the ex-dividend price behavior. Kato and Loewenstein (1995) examine stock price behavior around the ex-dividend day in the Japanese stock exchange. They find that prices rise on the ex-day and that tax effects appear to be secondary. The authors also conclude that intercorporate manipulative trading might be what is behind ex-day price movement and not the actual dividends. Both Lasfer (Lasfer, 1995) and Bell and Jenkinson (2002) analyze tax changes in the UK and found evidence supporting the existence of a tax effect in ex-dividend price behavior, while Michaely and Murgia (1995) also obtain results in favor of the tax explanation for the Milan stock exchange. Daunfeldt (2002) looks at the impact of tax changes in Sweden on ex-dividend prices and finds that his results are not robust enough to support a tax effect.

In the specific case of the Portuguese stock market, there are two papers that stand out. These include the contribution by Farinha and Sôro (2006) as well as the paper by Borges (2008).

Farinha and Sôro (2006) examine the ex-dividend stock price behavior in the Portuguese stock exchange between 1993-2002 and try to dissect the influence of taxation on prices. Farinha and Sôro (2006) classify investors according to their tax profile and find that the observed ex-dividend price reduction is in line with a fiscal explanation. In addition, they find that arbitrage strategies around the ex-dividend day do not lead to significant returns. Furthermore, the authors argue that the observed price drop is consistent with the theory and find limited evidence of the existence of a clientele effect.

The work by Borges looks at an earlier time period, from 1990-1998. Contrary to Farinha and Sôro (2006), Borges' (2008) results are not consistent with a tax-related explanation for the ex-dividend day price drop. However, like Farinha and Sôro (2006), Borges (2008) finds no evidence of clientele effects and argues that perhaps the price movements around the ex-dividend day are nothing more than an anomaly, a possible sign that markets are not always efficient.

These two papers are particularly relevant for our research because they have a lot in common with what we have set out to do, which is providing a more recent contribution to the analysis of ex-dividend pricing in the Portuguese stock exchange.

In summary, we can see that the decades-old debate on the influence of taxes on ex-dividend stock prices shows mixed conclusions, which demonstrates that our study makes a valuable contribution to the discussion.

III. Theoretical Framing and the Portuguese Tax System

A. The Portuguese tax system

The taxation of dividends and capital gains is of particular importance in our research. As such, it is important to clarify how the Portuguese tax system works and, more specifically, how it evolved throughout our sample period.

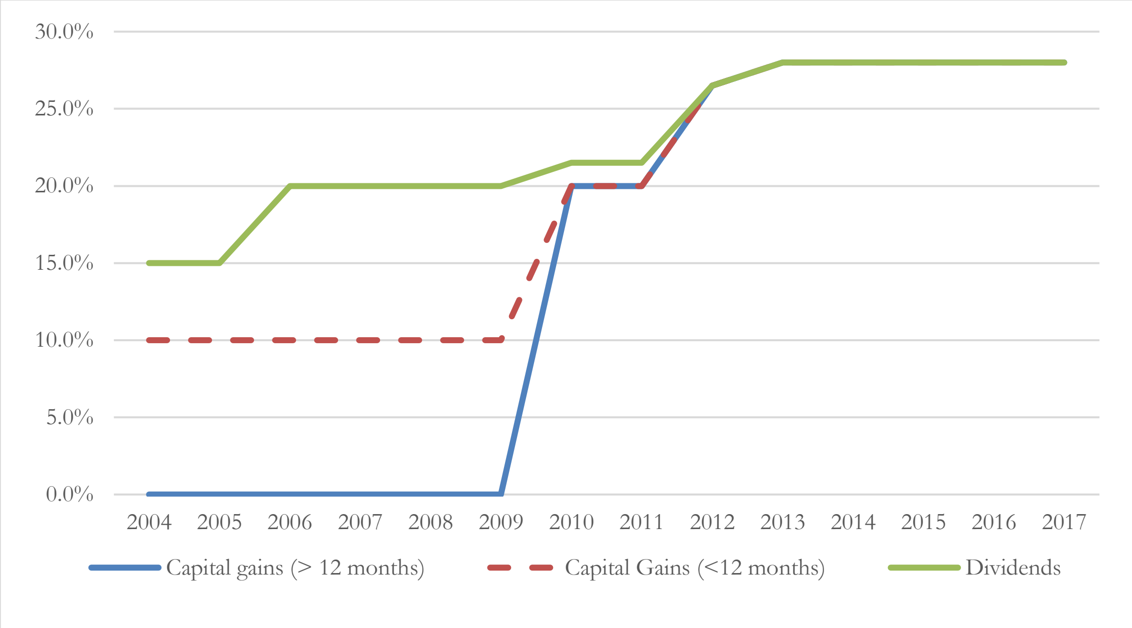
The tax system currently in place in Portugal is the result of a significant tax reform that took place in 1988. The IRS (Personal Income Tax) and IRC (Corporate Income Tax) tax codes were introduced, and several partial income taxes were replaced by global income taxation, both for individuals and firms. Although the bulk of the tax codes have not suffered many significant changes, the way dividends and capital gains are taxed has changed a few times over the years.

Regarding dividends, they are taxed first and foremost through a withholding tax, which is applied when the dividend is paid. This means that investors receive the dividend net of the aforementioned withholding tax. Nevertheless, one can choose to include them as global income to be taxed by the standard personal income tax. In that case, only 50% of the gross dividend will be included in the global income, with the amount that was withheld upon the payment of the dividend being deducted from the final tax collection. If one chooses not to include the dividends in the global personal income, the effective tax rate will be the withholding tax. As for corporations, they are obliged to include dividend income in the global income, with 50% being deducted from the total taxable amount. Capital gains taxation occurs whenever the net amount between gains and losses in buying and selling shares throughout a fiscal year is positive. Individual investors are subject to a capital gains tax rate, while capital gains made by corporations are taxed at the regular corporate tax rate.

Throughout our sample period, which goes from January 2004 to December 2017, there were some changes in the way dividends and capital gains were taxed. For example, for shares of firms acquired under a privatization program (until the end of 2002), only 50% of both dividends and capital gains were taxable for the first five fiscal years. Furthermore, in the first two years of our sample, investors were obliged to include dividend income in their personal income for taxation purposes. This requirement came to an end in 2006, when investors were able to choose whether to include dividends in global personal income or not. It is important to point out that, while our sample does include observations that were possibly affected by these caveats, we did not consider either of them in our analysis, for simplification purposes. One issue that concerns the taxation of capital gains is the fact that, until 2010, a differentiation was made in the taxation. If an investor held the shares for more than 12 months, he was considered exempt from capital gains taxation. When they were held for less than 12 months there were subject to a 10% autonomous tax rate. From 2010 onwards, this distinction ceased to exist and all capital gains resulting from stock market transactions were eligible for taxation.

Figure 1 shows the evolution of the taxation of dividends and capital gains throughout our sample period (2004-2017).

Figure 1
Capital gains and dividend taxation in Portugal throughout our sample period



As we can see, throughout most of our sample, dividends were subject to a much higher tax burden than capital gains. The difference was particularly stark between 2006 and 2009. It was then reduced to a small difference of 1.5% (in favor of capital gains) in 2010 and 2011, and ultimately the two tax rates were levelled out in 2012 and remained on a par until the end of the sample. Table 1 illustrates the evolution of the tax rates between 2004 and 2017 in numerical terms, as well as how the tax rates translate to the tax discrimination factor (TD) throughout the sample[2]. We calculate the tax discrimination factor using the following formula:

$$TD = \frac{(1-t_d)}{(1-t_{cg})} \tag{3.1}$$

[2] With regards to the tax discrimination, the following should be noted. Within the scope of our research, we decided to use the individual dividend withholding tax and the individual capital gains tax only, for simplification purposes. As such, the aforementioned caveats in dividend taxation (benefits in privatized firms, obligation to include in taxable income until 2006) were not considered in the computation of the tax discrimination factor. As for the capital gains tax, Farinha and Sôro (2006) suggest that the most important investor class in the Portuguese stock exchange is the long-term individual investor. Such an individual would very likely be in a high IRS tax bracket and, consequently, it would be more beneficial for the investor to have capital gains taxed at their tax rate and not to include them in their global personal income.

Table 1: Tax rate and tax discrimination factor evolution in the sample period

	Capital Gains[3]	Capital Gains	Dividends	TD (t_{cg} = 0)	TD (t_{cg} =0,1)
2004	0.00%	10.00%	15.00%	0.85	0.94
2005	0.00%	10.00%	15.00%	0.85	0.94
2006	0.00%	10.00%	20.00%	0.8	0.89
2007	0.00%	10.00%	20.00%	0.8	0.89
2008	0.00%	10.00%	20.00%	0.8	0.89
2009	0.00%	10.00%	20.00%	0.8	0.89
2010	20.00%	20.00%	21.50%	0.98	0.98
2011	20.00%	20.00%	21.50%	0.98	0.98
2012	26.50%	26.50%	26.50%	1	1
2013	28.00%	28.00%	28.00%	1	1
2014	28.00%	28.00%	28.00%	1	1
2015	28.00%	28.00%	28.00%	1	1
2016	28.00%	28.00%	28.00%	1	1
2017	28.00%	28.00%	28.00%	1	1
Mean				**0.92**	**0.96**

As the table shows, tax discrimination against dividends was strong in the first part of the sample, before it was reduced during the middle years and ultimately a situation of tax indifference between dividends and capital gains was established, from 2012 until 2017, the last year of our sample. The average tax discrimination factor during our sample period was 0.92 if we assume shares were held for over twelve months and 0.96 if we assume otherwise. This means that during the sample period, if an individual investor were to receive 100€ from investments (pre-tax), he would receive 8€[4] less (after-tax) if these 100€ came in the form of dividends, as opposed to capital gains.

B. Theoretical framing

Following the discussion on the taxation framework that was in place during our sample period, we will now explore how it could impact our research. As mentioned before, Elton and Gruber (1970) connected dividend and capital gains taxation on stock price behavior on the ex-dividend day. They postulate that, in an efficient market, the ex-dividend price drop should reflect the tax discrimination effect of dividends vis-à-vis capital gains. The marginal investor would then be indifferent as to whether the income comes from dividends or capital gains, and the observed price fall would allow the income tax rate of the investor to be inferred.

If there are no transaction costs, the equilibrium is then given as follows:

$$P_c - t_{cg} (P_c - P_o) = P_e - t_{cg} (P_e - P_o) + D(1\text{-}t_d) \qquad (3.2)$$

[3] Assuming shares were held for over twelve months. The same applies to the first column of the TD factor.
[4] Or 4€ if, before 2010, they had always held their shares for less than 12 months.

where:

P_c: Price on the day before the stock goes ex-dividend (Henceforth, cum-dividend price)
P_e: Ex-dividend price
P_o: Price at which the stock was purchased
t_d: Dividend tax rate
t_{cg}: Capital gains tax rate
D: Gross dividend

The left side of equation (3.2) represents the return an investor receives by selling on the cum-day, while the right side is the return of selling on the ex-day.

Rearranging this, we find the following:

$$\frac{P_c - P_e}{D} = \frac{(1-t_d)}{(1-t_{cg})} \tag{3.3}$$

This equation will be the basis of our study. Considering the evolution with respect to the Portuguese taxation environment that occurred throughout our sample period, we take Elton and Gruber's (1970) work as the foundation for our research. In an equilibrium such as that suggested by Elton and Gruber (1970), which takes equation (3.3) as a basis, the share price should fall by less than the dividend if dividends are more heavily taxed than capital gains. Additionally, and, given the characteristics of our sample, perhaps most importantly for our study, when one moves from a situation of a tax differential (favorable to capital gains) to tax indifference, the price fall should move from less than the dividend to the full amount of the dividend. Our research hypotheses, which we will formulate in the next section, stem from this theoretical reasoning.

IV. Research hypotheses, methodology and sample description

A. Research hypotheses

The general subject of our analysis will be to assess the impact of a potential tax effect on ex-dividend day stock price formation. As we saw in section II, our literature review, this has been the focal point of many studies, most of which conclude that, at least in part, ex-dividend price changes can be explained due to fiscal discrimination effects. The literature also tells us that, historically, most countries tax dividends more heavily than capital gains. This was also the case for most of our sample period. Under such circumstances and excluding other potential factors such as microstructure arguments or arbitrage costs, the expectation would be for the price to fall on the ex-day, namely by less than the full dividend amount. This brings us to our first hypothesis:

H1: In the presence of a tax effect, one would expect a positive relation between the price change and the dividend yield.

Furthermore, according to Elton and Gruber (1970) and equation (3.3), if prices do indeed reflect the presence of a fiscal effect, the price variation should be equal to the marginal investor's *TD*. In other words, we should be able to observe the equality of equation (3.3). This reasoning leads us to our second hypothesis:

H2: The average price variation, controlled by the dividend, should not differ significantly from the average tax discrimination factor (TD).

As mentioned before, what makes our sample period a particularly compelling research object for the study of ex-dividend prices, is the shift from a situation of tax discrimination to one of tax indifference. We based our final hypothesis on this idea. In our sample, in the period from 2004-2011, there is a tax differential unfavorable to dividends and from 2012 onwards we have a scenario of tax indifference. As such, and going back to Elton and Gruber (1970) if we look at equation (3.3), the stock price should fall by the full amount of the dividend. With that in mind, we formulate our third hypothesis:

H3: A switch from a higher tax on dividends than on capital gains ($TD<1$) to one of tax indifference ($TD=1$) is expected to increase the ratio of price variation over the dividend.

In a scenario where clientele effects exist in the market, as suggested by Elton and Gruber (1970) in their analysis of Miller and Modigliani (1961), it is likely that lower taxed individuals would prefer higher dividend stocks, and vice-versa. For this effect, we elected to test our first subsample only, i.e., the period where dividends were still more heavily taxed than capital gains.

H4: The ratio of share price change over dividend is expected to increase with the dividend yield, consistent with a clientele effect.

B. Methodology

After formulating our research hypotheses, we will now examine the methodology we chose to follow. To this end, we follow the methodology used by Farinha and Sôro (2005), who also chose Elton and Gruber's (1970) work as the foundation for their research. With a view to measuring the existence of a tax effect, it is important to relate the tax rates on dividends and capital gains with the dividend yield around the ex-day. Assuming no transaction costs and risk-neutral investors, this reasoning will lead us back to equations (3.2) and (3.3). For simplification purposes, we will henceforth refer to the left side of equation (3.3) as QVP. In Elton and Gruber's (1970) model, QVP represents the ex-dividend price behavior that, given a certain set of dividend and capital gains tax rates, would lead to an investor being indifferent to the timing of purchasing and sale of a stock. The mean of all observations would then be:

$$\overline{QVP} = \frac{1}{N}\sum_{n=1}^{N}\left(\frac{P_c - P_e}{D}\right) \tag{4.1}$$

where:

N: number of observations
P_c:: cum-dividend day closing price
Pe: ex-dividend day price (closing, opening, or adjusted close)
D: gross dividend

Following Elton and Gruber's (1970) reasoning, this statistic will allow us to estimate the marginal tax rates of the marginal investor[5].

Alternatively, one could compute the statistic through the following regression:

$$QVP_i = \overline{QVP} + \varepsilon_i \text{ , where } E(\varepsilon_i) = 0 \text{ and } Var(\varepsilon_i) = \sigma^2 \tag{4.2}$$

Nevertheless, Farinha and Sôro (2006) point out that several issues can be attributed to equation (4.2) in its capacity to properly estimate QVP. These issues had been previously mentioned by other authors that worked with the regression model in (4.2), such as Eades *et a.* (1984), Barclay (1987) or Bell and Jeckinson (2002). For example, it is not expected that QVP will follow a normal distribution. In addition, the residual term in (4.2) will most likely be heteroskedastic, since QVP is scaled by the value of the dividend, meaning that the weight given to observations with a lower dividend will be excessive. To solve this problem, Farinha and Sôro (2006) follow a methodology suggested by Boyd and Jagannathan (1994) and Bell and Jeckinson (2002), which we will also follow here. This methodology gives a reduced weight to observations where the dividend yield is lower, and the ex-dividend change is larger. The regression model is derived from the ex-dividend return of a stock $R_{e,i}$, which is given by:

$$R_{e,i} = \left(\frac{P_e - P_c + D}{P_c}\right)_i = (1 - \overline{QVP})\left(\frac{D}{P_c}\right)_i + \varepsilon_i \tag{4.3}$$

From here, a new regression can be derived:

$$\left(\frac{P_c - P_e}{P_c}\right)_i = \alpha_2\left(\frac{D}{P_c}\right)_i + \mu_i \tag{4.4}$$

Equation (4.4) shows the relationship between the change in price on the ex-day and the dividend yield. The QVP is now given by the slope of the equation. With this equation, the heteroskedasticity problems of regression (4.2) can be overcome. Furthermore, there is the possibility of adding an independent term to the regression as a means to evaluate market microstructure effects. This is suggested by several authors such as Farinha and Sôro (2006), Boyd and Jagannathan (1994) as well as Frank and Jagannathan (1998). It should be noted that, in the presence of microstructure effects, the expected sign for the

[5] In our case, a long-term individual investor in the highest personal income tax bracket.

independent term is negative, as these would impact ex-dividend prices negatively. The inclusion of the independent term yields the following regression:

$$\left(\frac{P_c - P_e}{P_c}\right)_i = \alpha_1 + \alpha_2 \left(\frac{D}{P_c}\right)_i + \mu_i \tag{4.5}$$

Regressions (4.4) and (4.5) will be what we will use to empirically test our hypotheses. It is important to point out that, in terms of actual data that is necessary to conduct our study, the variables we need are the following: the cum-dividend price, the ex-dividend price and the gross dividend per share. Nonetheless, while we use closing prices for the cum-dividend price, there is some debate around whether to use closing, opening, or even adjusted prices for the ex-dividend price. The case against closing prices, suggested by Elton and Gruber (1970), relates to the fact that, if one considers closing prices, i.e. including a full day of transactions, other factors that influence prices could also be at play, possibly diluting the actual impact of a fiscal effect. Other authors, such as Kalay (1982) argue against the use of opening prices, due to the possibility that the first transaction orders given by investors on the ex-day are likely to reflect a discount of the full amount of the dividend. A third possibility is that of using adjusted prices, either opening or closing. In our research, as no consensus was reached in the literature, and with the intention of being as thorough as possible, we opted to conduct our analysis in three ways. Using unadjusted closing prices, unadjusted opening prices, and adjusted closing prices. We compute our adjusted closing prices using a methodology followed by Borges (2008), which adjusts by the rate of return of the relevant stock market index[6] on the ex-day:

$$P_e' = \frac{P_e}{1+R_m} \tag{4.6}$$

where:

P_e: Ex-day closing price
P_e': Adjusted ex-day closing price
R_m: Return of the relevant stock market index on the ex-day

At this stage, we should clarify that we opted to work with panel data in our econometric analysis. Since our sample had both time-series[7] and cross-section[8] elements, we decided this was the best approach. According to authors such as Gujarati and Porter (2003) and Verbeek (2008), panel data analysis can yield more efficient and realistic models than traditional cross-section or time-series models. Gujarati (2003) also argues that panel data models can be particularly helpful in analyzing the dynamics of change, which could be adequate for our study, due to the changes in taxation that occurred over the course of our sample period.

[6] In our case, the Portuguese PSI-20 index.
[7] Observations, i.e., dividend payment occurrences throughout time.
[8] Observations, i.e., dividend payment occurrences for a given company. Each company serves as a cross-section identifier in our data sample.

There are three possible regression techniques in panel data analysis. Pooled Least Squares (PLS), the Fixed Effects Model (FEM) and the Random Effects Model (REM). PLS, also known as Common Effects Model, essentially disregards the panel characteristics of the data, by *pooling* the data together and then running the traditional least squares model. Both the FEM and REM are more adequate to study the intricacies of individual characteristics in a panel data set. In order to determine which of the three models is most adequate, one should first test FEM against PLS, through a likelihood ratio F-statistic, which tests if the FEM is redundant. The null hypothesis here is that PLS is the adequate model. If we cannot reject the null hypothesis, PLS is the most adequate model. If we reject the null hypothesis, we need to move to another test so as to assess whether to use FEM or REM. This test, named after Hausman (1978), compares the adequacy of the REM to that of the FEM. Here, the null hypothesis is that REM is the most adequate model. If we cannot reject the null hypothesis, we use REM. Otherwise, FEM is the most adequate model. In section V, where we present our results, further details on this model selection process will be provided.

C. Sample description

The main driver of our sample selection was to include the 2012 tax changes, in the sense that the sample should be significant and informationally complete both before and after the tax changes. Taking into account that the Portuguese stock market, which is the object of our research, is not as liquid as some of the other markets that have been used in ex-dividend day studies, we decided to include observations only from companies that were, at some point, constituents of the PSI-20 index. After that, we filtered the sample to remove companies that did not pay a dividend or only had limited trading volume around the ex-day.

We ultimately arrived at a sample of 262 observations from 23 firms, from 04/06/2004 until 12/12/2017. These included 129 observations in our dividend-capital gains fiscal discrimination period (2004-2011) and 133 observations in our fiscal indifference period (2012-2017).

All data was collected from Thomson Reuters *Refinitiv Eikon* software[9]. The data we collected consisted of all relevant information on dividend payments[10], historical stock prices on the cum-dividend and ex-dividend days for the firms in our sample during the sample period, and the historical returns of the PSI-20 index on all the ex-dividend days in our sample[11]. Additionally, we also obtained the information on the leavers and joiners of the PSI-20 index during our sample period from *Refinitiv Eikon*.

Table 2 presents the descriptive statistics of the main variables featured in our sample, both for every sample year separately and for the entire sample period.

[9] We then used *Yahoo Finance* and the websites of the dividend paying companies to cross-check if all information was accurate and if any relevant information was missing (for example, stock splits that could potentially affect how the price was reported).

[10] This includes Gross and Net dividend per share, announcement date, ex-dividend date and payment date.

[11] In order to compute the adjusted closing prices. See equation (4.6).

Table 2: Sample descriptive statistics

Notes: N. obs – Number of observations in the sample each year; N. Firms – Number of Firms in the sample; Pcum – Cum-dividend day price, presented in euros; Div – Gross dividend per share, presented in euros; D. yield – Dividend Yield, the ratio between the gross dividend and the cum price, presented as a percentage.

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
N. Obs		12	14	15	18	16	14	25	15	19	23	21	26	22	22	**262**
N. Firms		-	-	-	-	-	-	-	-	-	-	-	-	-	-	**23**
P_{cum} (€)	Max.	9.48	18.50	14.68	20.85	17.21	12.32	12.12	15.27	15.09	17.97	13.49	13.41	13.93	16.86	**20.85**
	Min.	0.55	0.76	0.72	1.79	1.11	0.63	0.81	0.51	0.37	0.50	0.59	0.55	0.15	0.39	**0.15**
	Mean	3.94	4.48	4.78	6.58	5.28	4.44	4.88	3.51	4.21	4.08	5.12	5.65	5.30	6.89	**5.03**
	Std. Dev.	3.11	4.97	3.86	5.18	4.15	3.50	3.92	3.85	4.92	4.44	4.00	4.20	4.09	5.08	**4.30**
Div (€)	Max.	0.24	0.50	0.48	0.48	0.58	0.58	1.00	1.30	0.44	0.50	0.40	0.75	0.47	0.61	**1.30**
	Min.	0.02	0.02	0.03	0.03	0.03	0.03	0.81	0.01	0.01	0.01	0.01	0.01	0.00	0.00	**0.00**
	Mean	0.10	0.15	0.16	0.17	0.16	0.15	4.88	0.18	0.15	0.14	0.15	0.19	0.15	0.22	**0.16**
	Std. Dev.	0.07	0.15	0.15	0.13	0.16	0.16	3.92	0.32	0.11	0.12	0.11	0.17	0.11	0.16	**0.16**
D. yield (€)	Max.	5.16	6.76	7.22	5.45	6.96	12.08	12.85	15.00	11.76	16.08	7.44	9.91	20.27	14.63	**20.27**
	Min.	0.84	1.48	1.24	1.01	0.88	0.49	0.36	0.92	0.95	0.95	0.81	0.64	0.75	0.51	**0.36**
	Mean	2.85	3.53	3.57	2.66	3.15	4.54	4.43	5.12	5.67	4.58	3.17	3.48	4.21	3.96	**3.96**
	Std. Dev.	1.12	1.58	1.95	1.17	1.71	3.13	3.16	3.62	3.55	3.48	1.89	1.99	4.05	3.16	**0.03**

Looking at the sample, it is worth mentioning that our average cum dividend price is 5.03€. This is more than four times less than that observed by Farinha and Sôro (2006) from 1993 to 2001 in the Portuguese Stock Exchange (20.92€). With a maximum of 1.30€ in 2011 and a minimum of 0.002€ in 2016 and 2017, we arrive at an average dividend per share of 0.16€. Comparing this with Farinha and Sôro (2006), we see that, like the average cum price, ours is substantially lower than what the authors found for the same stock exchange in their sample period (0.51€). Nevertheless, our sample shows an average dividend yield of 3.96%, which is higher than the 3.01% demonstrated by Farinha and Sôro (2006) for 1993-2001.

Table 3 presents descriptive statistics for the QVP throughout our sample period. We should recall that, as we saw in equation (4.1), the QVP for an observation[12] is calculated by scaling the ex-dividend price fall (P_c - P_e) by the gross dividend per share (D). We compute QVP according to closing, opening and adjusted closing ex-day prices.

Looking at table 3, we can see that using closing prices yields the highest average QVP (0.550), as well as the highest standard deviation (0.900). The lowest standard deviation happens when we use opening prices to compute QVP (0.804) and the use of adjusted closing prices leads us to the lowest QVP mean in all three approaches (0.491). In all three computing methods, the sample standard deviation is higher than the mean, which is consistent with what Farinha and Sôro (2006) obtained for their sample.

As we can recall from equation (3.3), Elton and Gruber (1970) equate the QVP to the tax discrimination factor (TD) between dividends and capital gains. While the observed average QVP is not particularly close to the TD of our sample period[13], we can observe such proximity in some years. In addition, one should note that closing prices provide

[12] i.e., a dividend payment event.

[13] See Table 1.

the observed QVP that is closest to the mean TD, although the difference for the other QVPs is not significant.

Table 3: QVP throughout our sample period

Notes: Pe – Ex-dividend day price, presented in euros; Pc – Cum-dividend day price, presented in euros; D – Gross dividend per share, presented in euros.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Closing Prices (P_e) used to compute QVP= (P_c - P_e)/D															
Mean	0.567	0.412	0.725	0.443	1.182	0.168	0.178	0.583	0.570	0.827	0.360	0.749	0.386	0.579	**0.550**
Std. Dev.	0.497	0.412	0.522	0.662	0.794	1.437	1.729	0.944	0.652	0.484	0.861	0.696	0.717	0.677	**0.900**
Opening Prices (P_e) used to compute QVP= (P_c - P_e)/D															
Mean	0.403	0.762	0.637	0.630	0.658	0.395	0.576	0.715	0.476	0.763	0.515	0.478	0.196	0.380	**0.535**
Std. Dev.	0.361	1.138	0.724	0.506	0.782	0.824	0.777	1.134	0.492	0.578	0.554	0.461	0.784	1.470	**0.804**
Adjusted Closing Prices (P_e) used to compute QVP= (P_c - P_e)/D															
Mean	0.450	0.273	0.551	0.440	1.055	0.335	0.154	0.404	0.542	0.609	0.174	0.703	0.416	0.740	**0.491**
Std. Dev.	0.482	0.462	0.437	0.573	0.794	0.893	1.761	0.673	0.801	0.679	0.870	0.599	0.686	0.543	**0.854**

As we had mentioned before, an important part of our research was assessing the difference between the 2004-2011 and the 2012-2017 periods. We applied the same methodology for these sub-samples as we did for the main sample. A more detailed look at the subsamples is provided in section V.

V. Results

In this section, we will present our empirical results. The econometric analysis we conducted to test our hypotheses was carried out using *EViews*, a statistical software package geared towards econometric analysis. We used this software to apply the PLS, FEM and REM models on our panel data. As explained in section 4, the model selection process is carried out through two[14] statistical tests that assess which model is most adequate for the data in question. These tests were also conducted in *EViews*.

In the first stage of our analysis, we looked at the full sample to evaluate H1, that is, the hypothesis of a positive relationship between the dividend yield and the price variation. In equations (4.4) and (4.5), the dependent variable is the ex-day price change, as a percentage of the cum-dividend price, and the independent variable is the dividend yield. As such, the results of the regression model will explain the relationship between the price variation and the dividend yield, which we expect to be positive. With the aim of testing our research hypotheses, we considered equations (4.4) and (4.5) to estimate our regression models. Like Farinha and Sôro (2006), we choose to also include an independent term to test for market microstructure effects. As such, these are the regressions we computed at this stage:

- Regression 5.1, using ex-dividend closing prices and no independent term.

[14] As explained in section 4, the process is the following: A first test is carried out, which assesses whether fixed/random effects are redundant. If they are not considered redundant, a second test, the Hausman (1978) test is carried out, which will decide whether to use fixed effects or random effects in the model.

- Regression 5.2, using ex-dividend closing prices and including an independent term.
- Regression 5.3, using ex-dividend opening prices and no independent term.
- Regression 5.4, using ex-dividend opening prices and including an independent term.
- Regression 5.5, using ex-dividend adjusted closing prices and no independent term.
- Regression 5.6, using ex-dividend adjusted closing prices and including an independent term.

Once we established our regressions, we had to estimate each regression and assess which was the most adequate panel data model to use. Table 6 illustrates how we conducted that process.

Table 4: Panel data model selection
Notes: PLS – Pooled Least Squares; REM – Random Effects Model.

Regression	Fixed Effects Test	Hausman Test	Model Decision
5.1	Cannot reject H_0	/	PLS
5.2	Cannot reject H_0	/	PLS
5.3	H_0 is rejected	Cannot reject H_0	REM
5.4	H_0 is rejected	Cannot reject H_0	REM
5.5	H_0 is rejected	Cannot reject H_0	REM
5.6	H_0 is rejected	Cannot reject H_0	REM

As we can see from the table above, our testing determined that, for the regressions estimated using closing ex-dividend prices, using the Pooled Least Squares model is the best approach. Both for opening prices and for adjusted closing prices, we determined that the REM is the most efficient model. It is important to point out that it is not possible to estimate a regression using random effects without an independent term. As such, regressions (5.3) and (5.4) are identical, and the same applies for regressions (5.5) and (5.6). For the sake of avoiding redundancy, we will present them together in our results. Our heteroskedasticity tests showed that the residuals in regression models (5.1) and (5.2) were indeed heteroskedastic. We corrected the heteroskedasticity problem by resorting to the Generalized/Weighted Least Squares method (GLS), as suggested by Gujarati (2003). Table 5 shows the results of our estimations for regressions (5.1) - (5.6).

Table 5: Full sample regression model results
Notes: Pe – Ex-dividend day price, presented in euros; Pc – Cum-dividend day price, presented in euros; D – Gross dividend per share, presented in euros.

Regression	Method	N. obs	α_1	α_2 (Div. Yield)	p-value (α_2)	R^2	Adjusted R^2
Closing Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.1	GLS	262	-	0.630304	0.0000	0.35405	0.35405
5.2	GLS	262	0,00505	0.757938	0.0000	0.37123	0.36881
Opening Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.3 & 5.4	REM	262	0.00451	0.695759	0.0000	0.34816	0.34565
Adjusted Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.5 & 5.6	REM	262	0.00459	0.711792	0.0000	0.45946	0.45738

Primarily, it is interesting to compare the explanatory power of the models. We can observe that the use of adjusted closing prices yields the model with the most explanatory power. In that model, the independent variables explain around 46% of the model, compared to around 35% both when using closing prices and when using opening prices. When comparing it to the models estimated by Farinha and Sôro (2006) using an approach similar to ours[15], we see that the explanatory power of the models is similar[16]. As we had mentioned before, authors such as Frank and Jagannathan (1998) and Boyd and Jagannathan (1994) suggest that the inclusion of an independent term, which in case of a negative sign, could mean microstructure effects in the market. In all the models we estimated, the independent term is negative, but of no statistical significance. This means that if there were microstructure effects during our sample, they were mostly insignificant. This result contradicts the findings of Frank and Jagannathan (1998) and Boyd and Jagannathan (1994), but is in line with Farinha and Sôro (2006), who did not find a strong enough case for microstructure effects in their own study of the Portuguese stock market. As for the other independent variable, the dividend yield, we find that it is statistically significant for all three ex-dividend prices, meaning we can consider the dividend yield as relevant and impactful in the formation of ex-dividend price changes. In all regressions, the sign of the dividend yield is positive, pointing towards a positive relationship between the dividend yield and the ex-day price change. Looking at the differences in the models estimated, we can see that the α_2 coefficient is quite similar in all of them, meaning that, irrespective of the ex-day prices we chose to estimate the model, they all predict a similar impact of the dividend yield on the ex-day price variation.

At this point, we should look back to the explanation we made in section 4 of equations (4.4) and (4.5). As we mentioned, the QVP is given by the slope of the equation, meaning that, in regressions (5.1-5.6), α_2 is our estimated QVP. To the effect of comparing the estimated QVP to the tax discrimination factor of our marginal investor, we look back at Table 1. We can see that all of our estimated QVPs are lower than the TD for the marginal investor[17]. For the sake of completeness, we ran a *Wald* test equating QVP to the tax discrimination factor of 0.92, for all our regressions. The null hypothesis was rejected in every test.

With regard to our first research hypothesis, we believe our results are robust enough to support it. We find evidence that confirms the existence of a positive relationship between the dividend yield and the ex-dividend price changes, in all three of our scenarios[18]. As for the second hypothesis, which aims to test Elton and Gruber's (1970) argument that QVP should be equal to the tax discrimination factor, we believe our results are not enough to support it. By looking at our estimated QVPs, we can see that

[15] Farinha and Sôro Farinha, J., & Sôro, M. (2006). Ex-dividend pricing, taxes and arbitrage opportunities: The case of the Portuguese Stock Exchange. Presentation at the 2006 Portuguese Finance Network Conference, do not present their results for adjusted closing prices. The authors did compute adjusted prices, using an adjustment process different to ours, but did not present the results as they were very similar to the unadjusted results.

[16] Farinha and Sôro ibid. present an R^2 of 0.4522 for opening prices and 0.2793 for closing prices.

[17] The TD for the marginal investor for our sample period was 0.92 in the scenario considering the capital gains tax of 0% until 2009 and 0.96 considering a capital gains tax of 10% until 2009.

[18] Using ex-dividend closing prices, ex-dividend opening prices and ex-dividend adjusted closing prices.

they are indeed lower than the tax discrimination factor for the sample and the *Wald* tests we ran confirm that initial suspicion. As such, we cannot accept our hypothesis that the QVP does not differ significantly from the tax discrimination factor. This means that we cannot confirm the presence of a tax effect in our sample, or that we, at least, need to acknowledge that there must be other factors influencing the ex-dividend price. This is consistent with the results of Borges (2008), but contradicts the findings of authors such as Farinha and Sôro (2006), Elton and Gruber (1970), Barclay (1987) and Elton *et al.* (2003).

A. *Results for the subperiods of 2004-2011 and 2012-2017*

In this subsection, we will analyze the most important of our three research hypotheses. As we have mentioned before, the added value of our work comes from the fact that we can observe, during our sample period, two different taxation scenarios. The remainder of our analysis is crucially tied with the shift from a situation where, in Portugal, dividends faced a heavier tax burden than capital gains (2004-2011) to a situation of tax indifference (2012-2017). To proceed with our study, it was necessary to split the initial sample in accordance with these scenarios. After splitting the sample, we had a subsample of 129 observations from 21 firms for the period of 2004-2011 and a subsample of 133 observations from 20 firms for the period of 2012-2017. Since we have already shown the yearly descriptive statistics in Table 2, it would be redundant to do so again. Table 6 presents the descriptive statistics for the relevant variables of both subsamples, but only the respective sample means.

Table 6: Descriptive statistics for 2004-2011 and 2012-2017

Notes: N. obs – Number of observations in the sample each year; N. Firms – Number of Firms in the sample; Pcum – Cum-dividend day price, presented in euros; Div – Gross dividend per share, presented in euros; D. yield – Dividend Yield, the ratio between the gross dividend and the cum price, presented as a percentage.

		2004-2011	2012-2017	Total
N. Obs		129	133	**262**
N. Firms		21	20	**23**
Pcum (€)	Max.	20.85	17.97	**20.85**
	Min.	0.51	0.15	**0.15**
	Mean	4.82	5.24	**5.03**
	Std. Dev.	4.13	4.47	**4.30**
Div (€)	Max.	1.30	0.75	**1.30**
	Min.	0.01	0.00	**0.00**
	Mean	0.16	0.17	**0.16**
	Std. Dev.	0.18	0.14	**0.16**
D. yield (%)	Max.	15.00	20.27	**20.27**
	Min.	0.36	0.51	**0.36**
	Mean	3.77	4.14	**3.96**
	Std. Dev.	2.50	3.14	**0.03**

From table 6 we can see that, relative to the main sample, the subsample for 2004-2011 has a lower average cum-dividend price and a lower mean dividend yield. In the second subsample (2012-2017), we can confirm the opposite, a higher average cum-dividend price and higher dividend yield. In addition to the descriptive statistics of the subsamples, it is worth looking at the average observed QVPs of both samples. Again, since we have already presented the yearly averages, only the averages for both samples are presented in Table 7.

Table 7: QVP for 2004-2011 and 2012-2017

Notes: Pe – Ex-dividend day price, presented in euros; Pc – Cum-dividend day price, presented in euros; D – Gross dividend per share, presented in euros.

	2004-2011	2012-2017	Total
Closing Prices (P_e) used to compute QVP = (P_c - P_e)/D			
Mean	0.511	0.587	**0.550**
Std. Dev.	1.071	0.697	**0.900**
Opening Prices (P_e) used to compute QVP = (P_c - P_e)/D			
Mean	0.601	0.470	**0.535**
Std. Dev.	0.801	0.804	**0.804**
Adjusted Closing Prices (P_e) used to compute QVP = (P_c - Pe)/D			
Mean	0.441	0.539	**0.491**
Std. Dev.	0.980	0.711	**0.854**

When looking at the observed QVPs for both subsamples, a few things are worth highlighting. As was the case with the main sample, the standard deviation is always greater than the mean, irrespective of which types of ex-dividend prices are used to compute QVP. In terms of how the subsamples relate to the main sample, there is contrast between opening ex-dividend prices and closing prices, both adjusted and unadjusted. When using opening prices, the 2004-2011 subsample presents a QVP mean higher than the total sample mean and a 2012-2017 mean that is lower than the total. The opposite happens when considering closing prices or adjusted closing prices. Comparing the two subsamples, the most striking difference is in the standard deviation. The standard deviation of the QVP is considerably smaller for the 2012-2017 subsample, namely when using ex-dividend closing prices (adjusted or not). When using opening prices, the standard deviation is practically identical for both subsamples.

In order to test H3, we need to estimate and compare the QVPs for both subsamples. For that purpose, we will have to use regressions (5.1)-(5.6) once again. However, this time, we will estimate the models using the two subsamples. It is important to understand that, even if the regressions used to estimate the model are the same, it is no guarantee that the same panel data model as used for the full sample will be identified as the most efficient for the subsample. For example, with the full sample, we identified the REM as the most efficient one when considering opening ex-dividend prices, but it is possible that, with the subsamples being different sets of data than the main samples, that a different model is identified for opening prices. For that reason, we conducted the model identification tests for all 12 relevant regressions, six for each subsample. Once again, when necessary, we corrected for heteroskedasticity by using GLS. Table 8 presents the estimation results for the 2004-2011 subsample and Table 9 for the 2012-2017 subsample.

Table 8: Regression model results for the period of 2004-2011
Notes: Pe – Ex-dividend day price, presented in euros; Pc – Cum-dividend day price, presented in euros; REM – Random Effects Model; GLS = Generalized Least Squares.

Regression	Method	N. obs	α_1	α_2 (Div. Yield)	p-value (α_2)	R^2	Adjusted R^2
Closing Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.1	GLS	129	-	0.602037	0.0000	0.28624	0.28624
Opening Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.4	GLS	129	0.001483	0.539862	0.0000	0.17196	0.16544
Adjusted Closing Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.5 & 5.6	REM	129	-0.002608	0.632274	0.0000	0.55982	0.47343

Table 9: Regression model results for the period of 2012-2017
Notes: Pe – Ex-dividend day price, presented in euros; Pc – Cum-dividend day price, presented in euros; REM – Random Effects Model; GLS – Generalized Least Squares; PLS – Pooled Least Squares.

Regression	Method	N. obs	α_1	α_2 (Div. Yield)	p-value (α_2)	R^2	Adjusted R^2
Closing Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.1	GLS	133	-	0.655307	0.0000	0.43284	0.43284
Opening Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.4	REM	133	-0.007743	0.792282	0.0000	0.63481	0.632021
Adjusted Closing Prices (P_e) used to compute $(P_c - P_e)/P_c$							
5.5 & 5.6	PLS[19]	133	-0.005198	0.765300	0.0000	0.59320	0.59009

Before assessing the results of the two subsamples, it is worth noting some aspects. For comparison purposes and to facilitate a better understanding of the argument we are presenting, we only include three regressions[20] per table, one for each type of ex-dividend price used in the estimation of the model. This is due to the intricacies of each model. For example, as we mentioned before, it is not possible to exclude the independent term when using the REM. With that in mind, when comparing REM with GLS or PLS, we choose to present the regression that includes the independent term, for comparability purposes. Otherwise, when comparing two regressions that were estimated using least squares, we present the regressions that were estimated without the independent term[21].

When comparing the results in Table 10 and Table 11 to the results from the main sample (Table 7), certain observations are worth mentioning. In terms of the explanatory power of the model, the first subsample (2004-2011) maintains the same trend we saw in the main sample, with the use of adjusted closing prices seemingly yielding a better fit than opening or closing prices. In addition, the α_2 coefficient, which is the estimated QVP, is lower for the period of 2004-2011 than in the main sample, for each type of ex-dividend price. Moreover, it is noteworthy that the second subsample (2012-2017) shows a perceptibly higher explanatory power than both the first subsample and the main

[19] Since no heteroskedasticity was found. the estimator we obtained. using the Pooled Least Squares model. is efficient and is the one we present.
[20] And, consequently, one QVP.
[21] This choice is based on the fact that the independent terms were statistically insignificant. As such, we believe that the regressions without independent terms provide more accurate estimations of QVP, thus making them more pertinent to test H3.

sample, across all types of ex-dividend prices. The estimated QVP for the second subsample is higher than in the main sample, for each type of ex-dividend price.

When comparing both subsamples to each other, we observed that the estimated QVP was considerably higher in the period from 2012 to 2017. Table 10 provides an overview of that comparison.

Table 10: Comparison of estimated QVP in the two subsamples[22]

Ex-Day Prices	α_2 (2004-11)	α_2 (2012-17)	Change	Change (%)
Closing Prices	0.602037	0.655307	+0.05327	**+8.8%**
Opening Prices	0.539862	0.792282	+0.25242	**+46.8%**
Adjusted Closing Prices	0.632274	0.765300	+0.13303	**+21.0%**

The increase in the estimated QVP is quite significant, particularly when using opening prices. Due to the aforementioned characteristics that distinguish the two subsamples, namely the shift from a scenario of tax discrimination that penalizes dividends to a scenario of tax indifference, we believe these results are consistent with Elton and Gruber's (1970) reasoning that a higher tax discrimination factor would bring a higher QVP (see equation 3.3) and signal the existence of a tax effect in the formation of ex-dividend prices. Accordingly, we are convinced that these results are sufficient to support and confirm H3. Crucially, it should be noted that while we did not find strong enough evidence to support the existence of a fiscal effect on ex-dividend prices, when we analyzed the full sample earlier in this section and then split the sample and compared the two periods where taxation was different, our results are consistent with the presence of a tax effect.

B. Clientele effects

With the aim of assessing our sample for tax clientele effects, we decided that it was more logical to use the subsample comprising the period between 2004-2011 instead of the full sample, as it could perhaps be futile to search for clientele effects in a period that contains a scenario of tax indifference. Miller and Modigliani's (1961) argument acknowledging the clientele effect was that one can expect that high-dividend stocks will be more attractive to investors less punished by taxation on dividends, i.e., with a higher TD, computed as in (3.1). If one links this to the relationship that Elton and Gruber (1970) established between the tax discrimination factor (TD) and the ex-dividend price change divided by the dividend (QVP), it is likely that, in the presence of clientele effects, the QVP would rise as the dividend yield rises.

For the purpose of assessing this, we follow a methodology similar to the one used by Farinha and Sôro (2006), splitting the sample into quintiles, ordered by dividend yield. We estimated the respective QVPs according to equation (4.4), using ex-dividend closing prices[23]. Table 11 shows the estimation results.

[22] As mentioned in section IV, the estimated QVP is given by the slope of the regression, i.e., the coefficient α_2.

[23] We carried out the same exercise using opening prices and adjusted closing prices, but the results were

Table 11: Clientele effects estimations[24]
Notes: D. Yield – Mean dividend yield in that quintile.

Quintile	N. obs.	D. Yield	α_{1Q}	α_{2Q}	α_{3Q}	α_{4Q}	α_{5Q}
1	26	1.26%	0.45889				
2	26	2.3%		0.48785			
3	25	3.1%			0.86995		
4	26	4.5%				0.54183	
5	26	7.7%					0.60748

As we can infer from the table, our results are not sufficient to support the existence of clientele effects. In addition to the trend in the QVP estimates not being in line with what is expected, the estimate for the first quintile is statistically insignificant, which further compromises the hypothesis. These results support the findings of Borges (2008) and Farinha and Sôro (2006) for the Portuguese stock market and, in broader terms, are also aligned with authors like Booth and Johnston (1984) and Menyah (1993).

Table 13: Clientele effects estimations[25]
Notes: D. Yield – Mean dividend yield in that quintile.

	2012	2013	2014	2015	2016	2017	Total
Closing Prices (P_e) used to compute QVP = (P_c - P_e)/D							
Mean	0.570	0.827	0.360	0.749	0.386	0.579	**0.587**
Std. Dev.	0.652	0.484	0.861	0.696	0.717	0.677	**0.900**
Opening Prices (P_e) used to compute QVP = (P_c - P_e)/D							
Mean	0.476	0.763	0.515	0.478	0.196	0.380	**0.470**
Std. Dev.	0.492	0.578	0.554	0.461	0.784	1.470	**0.804**
Adjusted Closing Prices (P_e) used to compute QVP = (P_c - P_e)/D							
Mean	0.542	0.609	0.174	0.703	0.416	0.740	**0.539**
Std. Dev.	0.801	0.679	0.870	0.599	0.686	0.543	**0.854**

V. Conclusions

The backbone of our study is the unique characteristics of the sample period we chose. By choosing a larger sample that included periods of both tax discrimination and tax indifference, we were able to test our research hypothesis more thoroughly. It is not the first time that a study has been carried out looking at the impact of taxation changes in ex-dividend prices. The likes of Booth and Johnston (1984), Michaely (1991), Zhang *et al.* (2008) for example, all carried out studies that included, to some extent, an analysis on the impact of changing tax regimes. Nevertheless, our study was, to the best of our

less precise.
[24] As mentioned in section IV, the estimated QVP is given by the slope of the regression, i.e., the coefficient α_2.
[25] As mentioned in section IV, the estimated QVP is given by the slope of the regression, i.e., the coefficient α_2.

knowledge, the first to do so in relation to the Portuguese stock market for a timeframe includes both tax indifference and tax differentiation regimes for dividends versus capital gains. While Farinha and Sôro (2006) did look at a change in dividend taxation, it was only for 2002, and it was still not a shift to the situation where dividends and capital gains were taxed identically.

Following Elton and Gruber's (1970) methodology, we first tested our full sample for the existence of tax effects in the formation of ex-dividend prices. The results we found were not robust enough to support this hypothesis, which is in line with Borges' (2008) findings, who also rejects the tax explanation in the Portuguese stock market. However, the characteristics of our sample enabled us to split the sample and carry out separate testing for the period before the 2012 tax changes and the period thereafter. When comparing the results of both subsamples, the differences we find point towards the existence of a tax effect. The introduction of a tax indifference scenario yields a notable increase in the estimated price change relative to the dividend, which is in accordance with Elton and Gruber's (1970) reasoning, as well as the findings of Farinha and Sôro (2006) for the Portuguese stock market. As such, we believe that our results show that the tax explanation for the formation of ex-dividend prices is credible.

Moreover, we tested our full sample, as well as our subsamples, for microstructure effects and did not find evidence supporting those arguments, suggested by Boyd and Jagannathan (1994) and Bali and Hite (1998). We also evaluated our first subsample, i.e., the period before the tax changes, searching for clientele effects. Our results were not consistent with the validity of the clientele hypothesis.

Our decision to use three different types of ex-dividend prices[26] adds to the significance of our results. We believe that the fact that for every hypothesis we tested, all three methods point in the same direction, albeit to varying degrees, is a testament to the empirical relevance of the study we conducted.

Our results enable not just investors to better anticipate the behavior of stock prices around dividend payments and the possible definition of trading strategies around the ex-dividend date, but also may help authorities in better addressing the possibility of tax arbitrage strategies by investors with particular tax profiles.

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[26] Closing prices, Opening prices and Adjusted closing prices.

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