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SCHOOL OF BUSINESS AND ECONOMICS

UNIVERSITY OF CANTERBURY

CHRISTCHURCH, NEW ZEALAND

Cum-Ex Trading – The Biggest Fraud in History?

Moritz Wagner
Xiaopeng Wei

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Department of Economics and Finance
School of Business
University of Canterbury
Private Bag 4800, Christchurch
New Zealand

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Moritz Wagner[1†]
Xiaopeng Wei[1]

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Abstract: In this paper, we analyse the extent of cum-ex trading in European markets. Based on abnormal trading volume, the estimated total tax loss due to illicit tax refunds of withholding tax on dividends amounts to approximately €10bn. We find that cum-ex trading is positively correlated with dividend yield, which is consistent with maximising returns from this strategy. Our results are robust, controlling for confounding effects and investors' tax heterogeneity. Relatively modest changes of how withholding taxes are administered help to prevent cum-ex trading. However, panel regressions indicate that it may still persist in some countries.

Keywords: Tax fraud, tax trading, cum-ex trading, dividend arbitrage, dividend stripping, abnormal trading volume

JEL Classifications: H26, G12, G14, G15

[1] Department of Economics and Finance, University of Canterbury, NEW ZEALAND

†Corresponding author: Moritz Wagner. Email: moritz.wagner@canterbury.ac.nz.

1. Introduction

A loophole in the tax codes of European countries allowed a large network of banks, brokers, hedge funds and law firms to obtain multiple refunds of withholding taxes on dividends that had only been paid once. This practice commonly known as “cum-ex” involves trading stocks quickly around the ex-dividend date with (cum) and without (ex) dividend rights to obscure who the actual owner of the stocks is. Tax authorities are unable to follow the change in ownership due to the underlying market microstructure and settlement process in place. Cum-ex trading usually requires several parties involved. This includes the original owner of the stocks, banks or brokers that borrow and short sale the stocks and another investor who buys the stocks just before the ex-dividend date (often using loan facilities provided by the banks to lever the trades). The settlement period for most security transactions is two or three business days referred to as T+2 or T+3. On the settlement date, payment must be received and the stocks delivered to the buyer.[1] If a transaction occurs for instance two days before the ex-dividend date, the settlement might overlap with the ex-dividend date resulting in stocks being bought cum dividend but delivered ex-dividend. The standard clearing process ensures that the buyer receives (i) the stocks at the ex-dividend price, (ii) a corresponding dividend compensation net of withholding taxes from the seller and (iii) a tax certificate issued by her depository bank.[2] In the case of cum-ex trading though, the seller crucially does not actually own the stocks. Rather, the seller is short selling the stocks. This form of short selling is allowed provided the seller has arranged to borrow the stocks or has entered into an agreement with a third party confirming that the stocks are available for settlement when it is due.[3] However, since the short sale is not recognised as such by the seller’s (or original owner’s) depository bank it also issues a tax certificate, resulting in double tax refunds.[4] In a final step, the buyer sells the stocks back to the original owner. The proceeds from the additional tax refunds are then shared among the parties.

[1] A shorter settlement period helps to reduce counterparty risk.
[2] The actual tax payable for an investor is based on the marginal tax rate and total income at year-end.
[3] See regulation EU No 236/2012 on short selling and certain aspects of credit default swaps, which came into effect on 1 November 2012.
[4] For example, see Spengel (2016) and European Parliament, 26 November 2018, “The Cum-ex files – Information Document” for a discussion of cum-ex strategies. Short selling in the context of cum-ex trading is different to the dividend capturing strategies discussed by Blau et al. (2011), which also involves short selling around the ex-dividend date.

Despite early warnings and testimonies from whistleblowers as early as 1992,[5] the practice continued and was so widespread that some banks even setup divisions specifically offering cum-ex trading to high net-worth or institutional investors. A consortium of international media outlets eventually helped to bring this practice into the spotlight in 2018.[6] In a well-researched article, the consortium estimates the loss in tax revenue from such trading to be a staggering €55bn. Ongoing investigations have since identified hundreds of companies allegedly involved with numerous suspicious transactions, while assets have been frozen around the world and several trials either have started or are pending at the time of writing.[7]

The described practice largely evolved from how withholding tax is collected. Typically, the dividend paying company withholds the tax on dividends and remits it to the treasury, while the shareholder's depository bank issues the tax certificate for a refund (if applicable). Intuitively a tax system where the remitter and bearer of the tax differs should improve tax compliance, since the remitter does not directly benefit from any wrongdoing. However, Slemrod (2008) highlights the problems of such a tax system and shows that enforcement and the cost to administer taxation varies with the identity of who actually pays the tax. More generally, he states that the standard economic view of who remits a tax liability is irrelevant for the efficiency of a modern tax system does not hold in the presence of tax avoidance or evasion.[8] Buettner et al. (2020) build on the same economics of tax remittance and examine the rational of withholding tax non-compliance. Based on a stylised model, they argue that cum-ex trading is mainly directed at exploiting existing tax laws with collusive elements as opposed to carrying out a form of arbitrage to hedge the usual price drop on the ex-dividend date. Tax authorities and lawmakers have failed to act upon numerous warnings or taken

[5] Individual witnesses and market participants including Deutsche Bank, public sector bank Helaba and the Association of German Banks describe cases of deliberate "production" of dividend withholding tax refund certificates in 1992 (see investigation report of the German parliamentary inquiry committee 2017, 18/12700, p. 117). A recent court ruling in Germany refers to illegal cum-ex transactions which even date back to 1990 (see FG Duesseldorf, court decision from 12 December 2016, 6 K 1544/11). See also BBC News, 9 June 2017, "Germany fears huge losses in massive tax scandal".

[6] Coordinated by CORRECTIV, a non-profit newsroom, 19 media outlets in 12 countries carried out the joined cross-border investigation. The report is based on reviewing 180,000 pages of documents (see "Cum-ex files" available at < https://cumex-files.com/en/>).

[7] The first trial about possible tax fraud in Germany has started in September 2019 in which two UK bankers face charges for allegedly obtaining illegitimate tax refunds of more than €400 million between 2006 and 2011 (see Bloomberg, 4 September 2019, "Ex-London bankers appear in first German tax scandal trial"). In addition, at least 570 suspicious cases between the years 2009 and 2011 have been identified in Germany (see report of the parliamentary inquiry committee 2017, 18/12700, p. 370), while in Denmark more than 420 companies and people are currently investigated for improper tax trading (see Reuters, 3 November 2018, "Denmark pushes to widen probe into multi-billion-euro tax fraud").

[8] The same logic applies to cum-ex trading although it seeks obtaining illegitimate tax refunds rather than trying to avoid or evade tax obligations.

measures too slowly. For example, Germany, which is at the centre of the scandal, has changed and updated its laws not until 2007. The new rules required that depository banks withhold *and* remit dividend taxes instead of the dividend-paying companies.[9] However, this only applied to domestic depository banks. Consequently, only investors with domestic bank accounts were precluded from obtaining illegitimate tax certificates. After that (at the latest), cum-ex trading went international. In Germany, cum-ex trading continued at least until 2012 when the government finally changed the rules for dividend withholding tax again (some 20 years after the first warnings). Since then, all banks (domestic and foreign) are responsible for withholding and remitting dividend taxes as well as issuing related tax refund certificates. As we will show in the following, consolidating both responsibilities on to one entity appears to be effective in preventing this fraudulent behaviour. However, somewhat surprising no EU-wide coordinated or joint efforts have been undertaken,[10] even though numerous reports that similar short-comings of the withholding tax systems exist in various other European countries including Austria, Switzerland, France, Italy, Spain, Belgium and the Netherlands.[11]

In this paper, we examine the incidence and extent of cum-ex trading in European countries. Apart from the insightful discussions of cum-ex trading in Germany by Dutt et al. (2018) and Buettner et al. (2020), we are not aware of other academic studies addressing the context of illicit dividend withholding tax refunds.[12] If cum-ex trading is indeed widespread, we would expect to see an increase in trading volume around the ex-dividend date. This follows from the normal settlement cycle, requiring short sales to be conducted two or three days before the ex-dividend date as described above.[13] Figure 1 shows that in most countries, the average number of stocks traded increases sharply in the days right before the ex-dividend date and reverses shortly afterwards.[14] Bialkowski and Jakubowski (2012) report a similar pattern in a related dividend stripping trading practice, which is based on single-stock futures with the sole purpose to reduce the tax obligation. Legitimate dividend capturing strategies involving stocks and clientele effects might therefore be alternative explanations for an increase in trading volume around the ex-dividend date (e.g. see Henry and Koski (2017), Koski and Scruggs (1998),

[9] See report of the parliamentary inquiry committee 2017, 18/12700, p. 161.
[10] We recognise that harmonising tax systems to eliminate loopholes and possibilities for tax-motivated trading across different countries is difficult, particularly if market participants collude.
[11] For example, see report of the parliamentary inquiry committee 2017, 18/12700, p. 349.
[12] In addition, Spengel et al. (2017) provide an appraisal of the tax loss due to cum-ex as part of the parliamentary inquiry in Germany.
[13] In case of over-the-counter transactions, any settlement period can be arranged (e.g. see Rau, 2010).
[14] The figures presented are based on the average number of stocks traded during the event window. Using total share volume or total euro volume instead yields virtually identical results.

Michaely and Vila (1995), Michaely and Murgia (1995), Lakonishok and Vermaelen (1986)).[15] In order to separate cum-ex effects, we take changes in the tax systems and alternative hypotheses for increased trading activities around the ex-dividend date into account. For example, the pattern shown in Figure 1 is only present before cum-ex was finally banned in 2012 in the case of Germany.[16]

[Insert Figure 1 about here]

The ramifications from cum-ex trading are obvious. It provides an opportunity for some investors to earn short-term profits at virtually no extra risk to the detriment of all other investors and the society as a whole. Reported losses from this practice vary widely. Apart from a few individual cases, references are often made without providing a reliable or legal basis. Our paper contributes to the understanding of the extent of this practice in several ways. First, we utilise actual market data to estimate corresponding losses based on an expanded sample of 4,729 firms across 12 European countries. Using abnormal volume over the days preceding the ex-dividend date, we estimate that the total loss to treasuries from cum-ex trading between January 2002 and August 2018 is €10.6bn based on mean-adjusted abnormal volume and €9.6bn based on a market model. France (€2.23bn – €2.5bn) and Germany (€1.58bn – €1.62bn) account for about 40% of the total loss.[17] Interestingly, we find that the combined loss in countries that have received far less attention in the general press (e.g. Spain, the Netherlands and Italy) amounts to about €5bn. Second, cum-ex trading is concentrated in high dividend yield stocks, which is consistent with maximising returns from this strategy. Our results are robust controlling for confounding effects on abnormal volume including systematic risk, idiosyncratic risk, transaction costs as well as investors' tax preferences and tax heterogeneity. Third, results from a panel regression suggest that cum-ex trading has largely disappeared in some countries (including Germany), but it might continue up to the present day

[15] A common practice of dividend stripping are so-called "cum-cum" trades, which entail a temporary shift of ownership between domestic and foreign shareholders in order to reduce the tax burden, might also contribute to higher trading activities. However, purchasing shares cum-dividend are obviously not restricted by the normal settlement period as cum-ex trading is. Since such trades rather spread more evenly over time, it is unlikely that they have an undue effect on our results. Also, cum-cum trades were banned in Germany from January 2016.

[16] Not shown in Figure 1, see Buettner et al. (2020) who also show that there is no abnormal volume for tax-exempt dividends.

[17] Estimated losses for Germany vary widely between €5bn and up to €30bn. Our estimates are close to Spengel et al. (2017) and Dutt et al. (2018) who estimate a minimum loss of about €7.2bn for the period 2005-2011 based on data provided by Clearstream, which acts as the central securities depository responsible for the post-trade infrastructure including settlement and custody. The analyses are based on non-public data requested by the special parliamentary inquiry committee in 2017 (see report of the committee 2017, 18/12700, p. 470). Reported losses for France, Italy, Denmark and Belgium are €17bn, €4.5bn, €2bn and about €200 million respectively.

in other countries such as France, Switzerland and Poland. Overall, we demonstrate why cum-ex trading has been so widespread and why it is likely to continue as long as inefficiencies in tax laws and administration exist.

The remainder of the paper is organised as follows. Section 2 describes the data and reports summary statistics. Section 3 presents the empirical findings and we conclude in Section 4.

2. Data

We obtain information on price, return, the number of stocks traded during a day and dividends of all publicly listed companies in the following countries from Compustat Global: Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Spain, Finland, France, Italy, the Netherlands, Norway and Poland. In addition, we obtain foreign exchange rates from Datastream to convert all stock data to one currency (Euro). Due to better data quality, we restrict our sample to common and preferred stocks (issue type code 0 and 1) in each country. Our sample comprises 4,729 firms and 36,591 firm-dividend observations over the period January 2002 to August 2018.

[Insert Table 1 about here]

Table 1 provides an overview of taxable dividends in each country. Firms in Belgium and Switzerland pay on average the highest annual dividends in nominal terms (€12.9 and €12.7 respectively), while firms in Spain (€0.53), Finland (€0.49) and Poland (€0.49) pay the lowest dividends on average. The standard deviation of individual dividends is highest in Switzerland (€58.63) and lowest in Spain (€0.35), while the average dividend yield varies between 3.29% in France and 5.08% in Norway. Because dividends can be paid quarterly, semi-annually or only once per year, annual dividend yield is calculated as the sum of dividends paid in a given year divided by the average price during the same year.[18] We include regular and special dividends, as both are subject to potential cum-ex trading. The total dividends paid over the sample period also varies substantially across countries, ranging from €50.8bn in Poland to €1,140bn in France. To calculate the corresponding maximum amount of withholding tax

[18] Most dividends in our sample are paid annually.

revenue (assuming no refunds are credited to individuals and corporates), we use the relevant tax rates on dividend income in each year from the OECD Tax Database. Column 7 shows that withholding tax on dividends are a considerable source of revenue for treasuries, highlighting the importance of an effective and unassailable withholding tax system. On the other hand, it might represent a strong incentive for some investors to stretch legal limits beyond simply minimising associated tax obligations.

3. Methodology and empirical results

3.1 Methodology

This section describes the event study framework we use to test for cum-ex trading in European markets. Since the nature of this practice requires settlement to overlap with the ex-dividend date, we focus on the abnormal number of shares traded around the ex-dividend date. The standard settlement cycle for securities trading varies across European countries between two and three days, commonly referred to in the industry as T+2 and T+3.[19] Therefore, the three days prior to the ex-dividend date are used as the event window.[20] We follow Ajinkya and Jain (1989), Cready and Ramanan (1991) and Campbell and Wasley (1996) and use a log-transformation of raw trading volume before estimating abnormal volume based on the following two approaches, mean-adjusted volume and a market model. The mean-adjusted abnormal volume is defined as the trading volume around ex-dividend date *i* on day *t* minus the average trading volume in the estimation period:

$$V\_adj_{it} = V_{it} - \bar{V}_i \quad (1)$$

[19] European regulators are pushing to shorten and to harmonise the settlement cycle in securities trading across its member states, e.g. see Regulation (EU) No. 909/2014 of the European Parliament and of the Council, which implemented a common settlement period of T+2 (includes exceptions for some transactions and situations) and Clearstream 02/10/2014, “European markets settlement cycle migration to T+2”, which includes an overview of the settlement cycles in different countries. The regulation became effective end of 2014, but with delays in some countries (e.g. Spain postponed implementation until the end of 2016, see Clearstream 26/09/2016, “Spain: T+2 settlement cycle for equities and impact on instructions postponed – Revision II”).

[20] Our results are qualitatively the same if we use *Ex-2* as event window or if we include the ex-dividend date.

where

$$\bar{V}_i = \frac{1}{t}\sum_{t=f}^{t=l} V_{it}. \qquad (2)$$

t is the number of days in the estimation period, f is the first and l the last day of the estimation period, for which we choose 100 trading days (with $f = -110$ and $l = -11$). This period is long enough to avoid measurement errors and ensures estimators are not influenced by the volume around the event (see MacKinlay, 1997).[21]

The market model is defined as:

$$V_{it} = \alpha_i + \beta_i \bar{V}_{mt} + \varepsilon_{it} \qquad (3)$$

where V_{it} is the number of stocks traded on day t during the same estimation period as above prior to ex-dividend date i, α_i and β_i are obtained with ordinary least squares estimation and ε_{it} is the usual error term. The average market trading volume on day t, $\bar{V}_{mt}$, is calculated as follows:

$$\bar{V}_{mt} = \frac{1}{n}\sum_{i=1}^{n} V_{it} \qquad (4)$$

where n is the number of stocks in the market. The market model abnormal trading volume during the event window is then calculated as:

$$V\_mm_{it} = V_{it} - (\alpha_i + \beta_i \bar{V}_{mt}). \qquad (5)$$

For both approaches, a dividend event with missing trading volume on more than 40 days during the estimation period or with missing trading volume on any day during the event window is dropped.

[21] The results reported below are largely unaffected when we use 150 days or 250 days as estimation period, or if we centre the estimation period around the ex-dividend day (e.g. 50 days on either side).

3.2 Abnormal volume and estimated tax loss from cum-ex trading

Table 2 reports daily abnormal trading volume relative to the average trading volume during the estimation window. Corresponding with Figure 1, the average number of shares traded during the event window increases substantially in most countries. The mean-adjusted abnormal trading volume ranges between 103% in Austria and a staggering 885% in Poland. Abnormal volume estimated by the market model is somewhat lower ranging between 85% in Austria and 948% in Poland. The *t*-statistics test the hypothesis that there is no difference between the estimation and event period. All tests are statistically significant on the one percent level, rejecting the null hypothesis.

[Insert Table 2 about here]

Investors can maximise the returns from cum-ex trading by focussing on stocks with high dividend yields. In Table 3, we therefore condition on the dividend yield as a possible refinement of cum-ex trading. If investors indeed maximise gains from cum-ex trading by focusing on high dividend yield stocks, we would expect to see higher abnormal trading volume for such stocks. We evaluate alternative hypotheses for the increased trading activity around the ex-dividend date, which have also been found to be positively related with dividend yield in section 3.3 (e.g. tax heterogeneity and short-term dividend arbitrage strategies). Apart from a few exceptions, both mean-adjusted abnormal trading volume and market model estimates increase almost monotonically with dividend yield. The number of shares traded increase on average about twice as much in the first three quartiles and more than 400% in the top quartile. The difference between the quartiles is statistically significant in most of the countries.

[Insert Table 3 about here]

We next calculate the tax loss from cum-ex trading for each dividend event *i* in country *j* as:

$$Tax\ loss_{i,j} = CAV_i \cdot Div_i \cdot \tau_{j,y} \tag{6}$$

where CAV_i is the cumulative abnormal volume during the event window, Div_i is the gross dividend paid and $\tau_{j,y}$ is the withholding tax rate in a given year. The total tax loss is then calculated as:

$$Total\ tax\ loss_j = \sum_{i=1}^{n} Tax\ loss_{i,j}. \tag{7}$$

The total loss in tax revenue for treasuries in Europe amounts to €10.6bn based on mean-adjusted abnormal volume and €9.6bn based on the market model. France and Germany together, which have been reported to be the most affected countries, account for about 40% of the total loss. Yet, we also find considerable tax losses in countries that have received less attention, most notably in Spain, the Netherlands and Italy. Although cum-ex trading was arguably widespread in Denmark, the relatively low value of tax loss is less surprising since transferring shares was not necessarily required for obtaining a tax refund certificate and hence is not reflected in actual trading data.[22] Overall, our estimates are below those reported for Germany by Spengel et al. (2017) who estimate a minimum loss of about €7.2bn. However, this estimate is based on non-public data from Clearstream requested by a special parliamentary inquiry, which is otherwise not available for research. Therefore, estimating the loss due to cum-ex trading using simple abnormal volume measures are rather conservative despite potential confounding factors such as clientele effects and other short-term trading activities around the ex-dividend date. We also do not account for multiple tax refunds where stocks are borrowed or sold short more than once via a series of OTC trades in combination with forward contracts.[23] Our results are similar to Buettner et al. (2020) who find a tax loss for Germany of up to €1.01bn based on regression analysis.

[Insert Table 4 about here]

3.3 Abnormal volume and firm characteristics

In this section, we follow existing literature on abnormal volume around the ex-dividend date and provide a formal regression analysis of cum-ex trading based on panel data (by firm and dividend event). In particular, we evaluate the positive association between abnormal

[22] For example, see the public hearing of ECON/TAX3 Committee of the European Parliament, "Cum-ex scandal: Financial crime and the loopholes in the current legal framework"; and the New York Times, 5 October 2018, "Where in the world is Denmark's $2 billion" for an illustrative presentation of cum-ex trading and the shortcomings of the tax system in Denmark.
[23] For example, see Spengel (2016) and Rau (2010).

volume and dividend yield taking general tax-motivated trading hypothesis, including legitimate dividend capturing strategies, into account in addition to cum-ex trading. The model specification is:

$$CAV_{it} = \alpha + \beta DY_i + \gamma Controls_{it} + \varepsilon_{it}, \tag{8}$$

where CAV_{it} is the cumulative daily abnormal trading volume for dividend event i over the three-day event window t.[24] The constant term, α, captures the average cumulative trading volume. DY_i is the dividend yield calculated as the euro amount of dividends per share divided by the cum-dividend stock price. $Controls_{i,t}$ is a vector that includes firm-specific variables to account for important determinants of the average trading volume around the ex-dividend date identified in prior literature. More specifically, we consider the expected price drop ratio, *PDR*, on ex-dividend days to control for the tax preference of investors and other potential short-term (dividend capturing) trading activities around the ex-dividend date. Tax heterogeneity has been found to be a major factor for abnormal trading volume around the ex-dividend date and thus should be considered in empirical analysis.[25] Elton and Gruber (1970) demonstrate that the ex-day price drop ratio reflects the relative value of dividends versus capital gains:

$$PDR = \frac{Price_{cum} - Price_{ex}}{dividend} = \frac{1-t_d}{1-t_g}, \tag{9}$$

where $Price_{cum}$ is the cum-dividend day price, $Price_{ex}$ is the ex-dividend day price, t_d is the dividend tax rate and t_g is the capital gains tax rate. Existing studies document that the ex-day price drop ratio is determined by the average tax preference of all traders for dividend relative to capital gains, risk tolerance and the arbitrage risk (e.g. see Michaely and Vila, 1995; Chen et al., 2013). We follow Chen et al. (2013) to calculate the ex-day price drop ratio as:

$$PDR = \frac{P_{cum} - \frac{P_{ex}}{1+\widehat{r_i}}}{dividend}, \tag{10}$$

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[24] The measure of abnormal volume is based on Dhaliwal and Li (2006). However, the results reported in this section hold if we use our estimated abnormal trading volume from above (i.e. mean-adjusted and market-model abnormal volume).

[25] Literature on tax-induced trading suggests and provides empirical evidence that investors with tax advantages (disadvantages) on dividends hold or buy (sell) stocks cum-dividend (before the ex-date and buy them back on the ex-date or later), e.g. see Lakonishok and Vermaelen (1986), Michaely and Murgia (1995), Dhaliwal and Li (2006), Zhang (2008) and Chen et al. (2013).

where P_{cum} is the cum-dividend closing price, P_{ex} is the ex-dividend closing price, $\hat{r}_i$ is the estimated daily return based on CAPM.[26] In addition, we include measures for (systematic and non-systematic) risk and transaction costs since both reduce trading activities (e.g. see Michaely and Vila, 1995, 1996; and Michaely et al., 1996). The risk measures also account for the market turmoil during the global financial crisis (2007-2009) and the Eurozone debt crisis (2010-2012) in our sample period. Including risk further captures general limits to the profitability from cum-ex trading and avoids measurement errors from a model that only accounts for the upside.[27] Following Dhaliwal and Li (2006), we use the estimated CAPM beta, β, from regressing individual stock returns on market returns based on the estimation period (days -110 to -11 before the ex-dividend date) as a measure of systematic risk.[28] Idiosyncratic risk, $\sigma_\varepsilon/\sigma_m$, is calculated as the standard error of the CAPM residuals divided by the standard error of the market returns during the estimation window. Transaction costs, *TC*, are frictions to cum-ex trading since higher transaction costs reduce trading profits (and activities). We follow Karpoff and Walking (1988), Naranjo et al. (2000) and Dhaliwal and Li (2006) and calculate transaction costs as the inverse of the cum-dividend closing price. We also include the logarithm of average daily market capitalisation of a stock during the estimation window to control for the effect of firm size, if any, on abnormal volume. Lastly, we create a dummy variable that equals one for all dividend events between 2013 and 2018. We choose this period for two reasons (i) to account for (possible) changes in the administration of dividend withholding taxes and (ii) to test how widespread cum-ex trading was and potentially still is in the most recent period. For example, lawmakers in Germany changed legislation to ban cum-ex trading that came into effect in 2012. Yet, we are not aware of a European-wide joined action to halt this practice.

In Panel A of Table 5 we first report results from a benchmark estimation without controls before turning to the full specification of equation (8).Consistent with Figure 1, measures of the three-day cumulative abnormal volume, *CAV*, suggest a significant increase in the number of shares traded around the ex-dividend date in all countries. The constant terms vary between 3.02 and 4.46, all with *t*-statistics significant on the 1% level. Similarly, the coefficient

[26] Alpha and beta are estimated using return observations from the 100-day estimation period as described in section 3.1.

[27] For example, large price changes between the time the stocks are sold short and bought back might affect the overall return from the illicit tax refund. However, any gains and losses due to price fluctuations can be eliminated if split between the parties.

[28] Market return is the daily return on MSCI country indices and the risk free rate is proxied by the 3-month EU-wide interbank borrowing rate.

estimates on DY_i are positive and statistically significant in nine out of 12 countries (Germany, France, Italy, Denmark, Switzerland, Spain, Finland, Netherlands and Poland, but not in Austria, Belgium, and Norway). The magnitude of the coefficient estimates is somewhat misleading since the average dividend yield (particularly for interim dividends) tends to be rather small. To put it into perspective, the coefficient estimates for a mean sized dividend yield in France give a fitted (three-day) abnormal volume of 4.08 (3.05 + 0.314 * 3.29%*100) or 408%. Similarly, for a firm-dividend event that is one standard deviation larger than the average dividend yield in France the fitted abnormal volume equals to 488% (4.08 +0.314* 2.55%*100).

[Insert Table 5 about here]

In Panel B of Table 5, we include controls for the relation between trading volume and firm-specific characteristics used in prior literature. The $Post2013_i$ dummy and interaction term $DY_i{*}Post2013_i$ capture the differences in abnormal trading volume and the effect of dividend yield in the period January 2013 to August 2018, our main variables of interest.

We find mixed results for the period after 2012, with lower (higher) *CAV* in four (one) countries and no change in the remaining countries. For example, the negative and significant coefficient of *Post2013* for Germany suggests lower *CAV* after the change in legislation. Moreover, the coefficient on the interaction term, $DY_i{*}Post2013_i$, is insignificant, i.e. *DY* has no effect on abnormal trading volume after 2013. To the extent that DY indeed captures activities from profit-maximising cum-ex traders, the change in legislation appears to have helped to curb this practice in Germany. By contrast, clientele effects and other legitimate tax-induced trading that is positively related with *DY* should be unaffected by changing how withholding taxes are administered (as opposed to the actual tax rate). Apart from Netherlands, that has a significantly negative coefficient estimate on $DY_i{*}Post2013_i$, we do not find a reduced effect of *DY* in any of the other countries. In case of France, Poland and Switzerland, the coefficient on $DY_i{*}Post2013_i$ is significantly positive, suggesting that the effect of dividend yields on abnormal trading volume has increased, if anything, in recent years. Part of this increased effect might be related to (increased) cum-ex trading in these countries.

The coefficient on the price drop ratio is only significantly positive for Austria. Therefore, tax-preference and other short-term trading activities seem to be less important explaining abnormal trading volume before the ex-dividend day in European countries. This might be partially due to the varying differences between dividend withholding and capital gains tax rates. For example, while capital gains are not taxed in Belgium and Switzerland, in other countries both capital gains and dividends are taxed but the actual capital gains tax depends on several provisions including holding period, ownership rate thresholds in a company, minimum tax allowances, deductible expenses, whether shares are held by a person or legal entity and whether the holder of the shares resides within or outside the country of the dividend paying company. The complex tax system across European countries, makes it difficult to account for tax heterogeneity among investors using the expected price drop ratio. Nonetheless, the coefficients on *PDR* for Belgium and Switzerland with unambiguous tax differences between capital gains and dividends are close to zero and statistically insignificant. The coefficients of systematic risk, β, are negative and significant in seven countries. The results are consistent with the findings reported by Dhaliwal and Li, (2006) and Chen et al. (2013) that risk reduces trading activities. Yet, idiosyncratic risk, *IR*, is only negatively related to abnormal volume in Germany and Spain. Interestingly, the coefficient on *IR* is positively significant in Italy, suggesting that investors are more willing to trade before the ex-dividend date when idiosyncratic risk is higher.[29] The coefficients of transaction costs, *TC*, are significant and negative in Spain and Finland. Consistent with the literature, it suggests that higher transaction costs reduce abnormal trading volume. Apart from one country (Spain), firm size proxied by average market capitalisation, *ACAP*, has no discernible effect.

To analyse further to what extent dividend yield accounts for cum-ex trading and to separate the effect from those of other tax-induced trading activities, we apply a two-stage regression process as a robustness test. In the first stage, we regress dividend yield on the expected price drop ratio for each event, since short-term trading activities and the expected price drop ratios also increase with dividend yield (as does cum-ex trading to maximise profits):

$$DY_i = \gamma + \theta PDR_i + \varepsilon_{it}. \quad (11)$$

By doing this, we separate the part of dividend yield that is related with investors' short-term trading activities due to tax preference and heterogeneity. We then employ the coefficients of

[29] The results are consistent with studies documenting a positive volume-volatility relation (e.g. see Chen et al., 2001; Xu et al., 2006; and Griffin et al., 2006).

PDR, $\hat{\theta}$, and the constant term, $\hat{\gamma}$, to estimate the dividend yield, $\widehat{DY}$, and calculate the residual of *DY* as:

$$DY\_residual_i = DY_i - \widehat{DY_i}. \quad (12)$$

The second-stage regression is as following:

$$AV_{it} = \alpha + \beta DY\_residual_i + \gamma Controls_{it} + \varepsilon_{it}. \quad (13)$$

Assuming that *DY_residual* captures the effect of dividend yield associated with cum-ex trading rather than other activities, a statistically significant and positive coefficient estimate of *DY_residual* would suggest the likely existence of cum-ex trading, since stocks with higher dividend yields can be used to claim higher tax refunds.

[Insert Table 6 about here]

Table 6 reports results from the first stage regressions. *PDR* is (by design) negatively related with *DY* and statistically significant in seven out of 12 countries. The results with *DY_residual* are reported in Table 7 and are very similar to those reported in Table 5. As before, we first regress *CAV* only on *DY_residual* (Panel A) and find that it is significantly positive in all markets apart from Belgium and Norway. After controlling for firm specific variables (Panel B), the coefficient is positive and significant in Austria, Denmark, Finland, France, Germany, Netherlands, Poland and Spain. For Germany, we find consistent results for the *Post2013* indicator, which is negative and significant, again suggesting that cum-ex trading is either less pronounced or no longer present after the legislation change in 2012. Similarly, for France, Poland and Switzerland, the coefficient estimates on the interaction term, *DY_residual*Post2013*, are still significantly positive. Overall, our results suggest that cum-ex trading might have abated in Germany but not in all European countries.

[Insert Table 7 about here]

4. Conclusion

Flaws in the tax systems and general inertia of lawmakers in European countries have allowed a network of investors, banks and law firms to obtain refunds of withholding taxes on dividends that have not been paid before. Using abnormal trading volume around the ex-dividend date, we estimate a total loss to European treasuries from cum-ex trading of around €10bn. This estimate is based on market data and a widely used form of cum-ex trading that involves short selling shares and repurchasing them quickly around the ex-dividend date, but we will probably never know the full extent of this practice. We understand the (common) positive association between abnormal volume and dividend yield as a refinement of cum-ex trading to maximise profits. Our view is supported when we control for alternative hypothesis for abnormal volume before and after the ex-date, including investor's tax preferences, risk measures and transaction costs. Our results also indicate that cum-ex trading might have subsided in some countries including Germany, which changed how withholding tax is administered, but it may still be present in other countries. The existence of cum-ex trading is disheartening, not only because it joins an already long list of scandals and wrongdoings in the financial sector, but in particular because it has been well-known and ignored by regulators and government officials for many years allowing the pilferage of taxpayers' money.

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Figure 1

The figure shows the average trading volume (number of shares) of all stocks traded in European markets within 30 days on either side of the ex-dividend date where the dividend payments are subject to withholding tax. The time-period is January 2002 – August 2018.

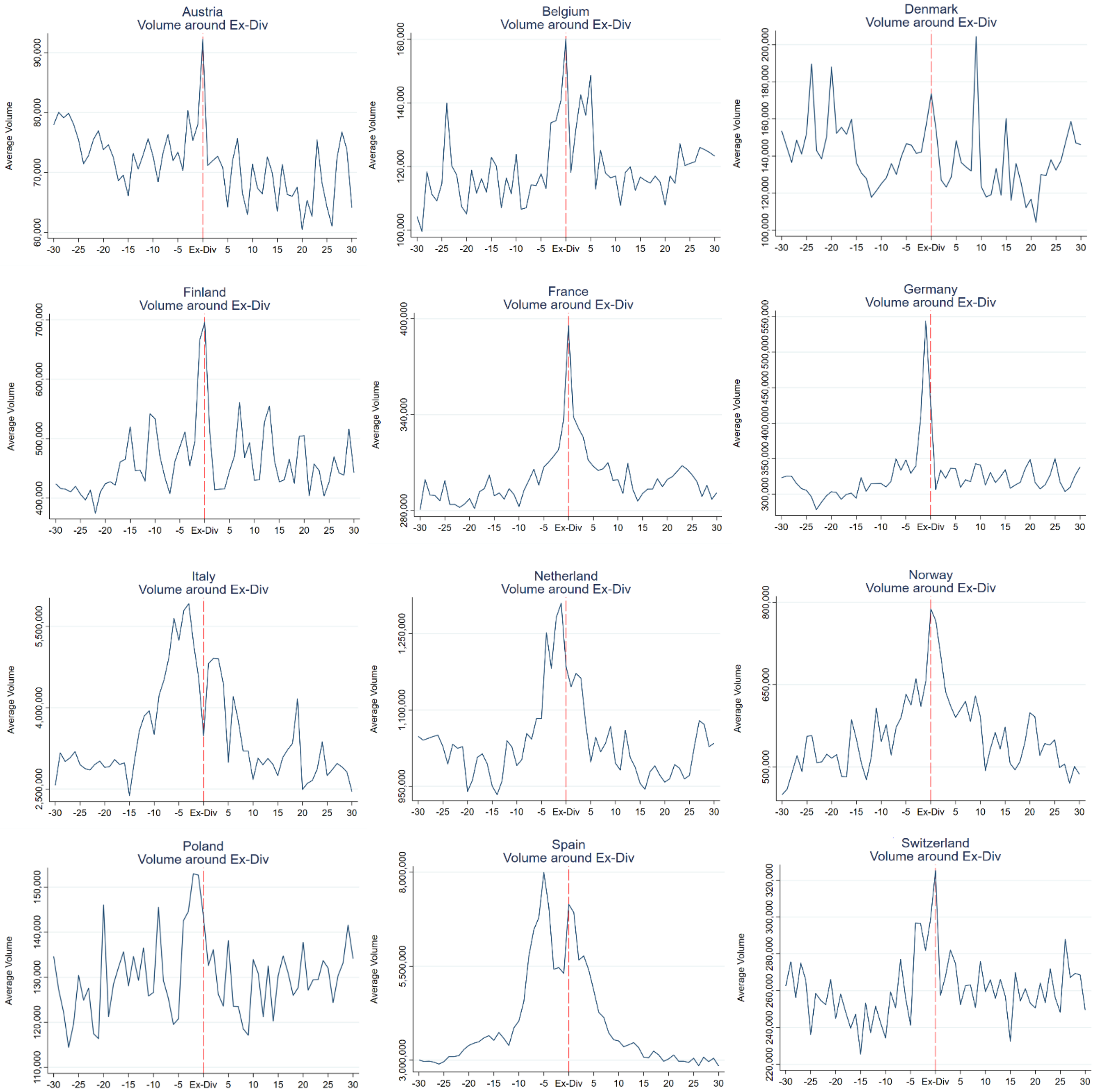

Table 1

Summary statistics of taxable dividends in European countries

The table reports summary statistics of ordinary and special dividends on common and preferred stocks from 12 European countries. Annualised dividend yield is calculated as the sum of dividends paid in a given year divided by the average price during the same year. Total withholding tax is based on the respective tax rate in each year obtained from the OECD Tax Database. The sample period is from January 2002 through August 2018.

Country code	Country name	Number of companies	Number of dividends	Mean annual dividend (in EUR)	Standard deviation of annual dividend (in EUR)	Annualised dividend yield	Total dividend paid (in million EUR)	Total withholding tax (in million EUR)
AUT	Austria	161	1,177	1.17	1.88	4.16%	51,000	13,100
BEL	Belgium	218	1,766	12.93	18.81	4.42%	171,000	32,300
DNK	Denmark	211	1,458	2.80	16.99	3.54%	69,600	29,500
FIN	Finland	226	2,117	0.49	0.45	4.91%	202,000	61,700
FRA	France	889	7,453	2.84	8.86	3.29%	1,140,000	442,000
DEU	Germany	885	5,837	2.42	5.66	3.47%	724,000	208,000
ITA	Italy	474	3,136	5.32	1.85	4.07%	386,000	65,300
NLD	Netherlands	289	2,631	1.30	0.97	3.37%	465,000	114,000
NOR	Norway	279	1,779	2.34	0.89	5.08%	156,000	43,900
POL	Poland	434	2,027	0.49	1.35	4.53%	50,800	9,620
ESP	Spain	272	3,827	0.53	0.35	4.56%	870,000	219,000
CHE	Switzerland	391	3,383	12.72	58.63	4.39%	697,000	168,000

Table 2

Average abnormal trading volume around the ex-dividend day

The table reports average abnormal trading volume defined as the ratio of estimated daily abnormal trading volume during the event window over the daily average trading volume during the estimation period. The *t*-statistics test the hypothesis that abnormal volume equals zero. The sample period is from January 2002 through August 2018.

		Mean-adjusted			Market model		
Country code	Country name	Abnormal volume (%)		*t*-stat.	Abnormal volume (%)		*t*-stat.
AUT	Austria	103%	***	(11.05)	85%	***	(10.53)
BEL	Belgium	154%	***	(8.90)	135%	***	(8.47)
DNK	Denmark	187%	***	(10.72)	174%	***	(9.74)
FIN	Finland	360%	***	(14.21)	322%	***	(13.71)
FRA	France	331%	***	(13.72)	328%	***	(13.44)
DEU	Germany	160%	***	(29.72)	144%	***	(26.71)
ITA	Italy	201%	***	(10.91)	175%	***	(9.89)
NLD	Netherlands	350%	***	(9.52)	289%	***	(9.89)
NOR	Norway	411%	***	(6.86)	309%	***	(6.77)
POL	Poland	885%	***	(5.10)	948%	***	(4.64)
ESP	Spain	228%	***	(13.35)	185%	***	(11.05)
CHE	Switzerland	187%	***	(4.96)	150%	***	(5.09)
Mean		288%			261%		

*** p<0.001
** p<0.05
* p<0.1

Table 3

Average abnormal trading volume based on dividend yield quartiles

The table reports average abnormal trading volume based on dividend yield quartiles formed each year. Abnormal volume is defined as the ratio of estimated daily abnormal trading volume during the event window over the daily average trading volume during the estimation period. Panel A is based on mean-adjusted trading volume, whereas Panel B is based on abnormal volume estimated from a market model. The sample period is from January 2002 through August 2018.

Panel A - Mean adjusted abnormal volume

Country code	Country name	Q1	Q2	Q3	Q4	Dif. 4-1		*t*-stat.
AUT	Austria	87%	82%	81%	164%	78%	***	(2.39)
BEL	Belgium	106%	88%	144%	278%	172%	***	(3.04)
DNK	Denmark	118%	144%	145%	346%	228%	***	(3.72)
FIN	Finland	337%	279%	315%	510%	173%	**	(2.03)
FRA	France	188%	245%	261%	631%	443%	***	(5.17)
DEU	Germany	101%	120%	157%	258%	157%	***	(10.24)
ITA	Italy	156%	139%	192%	318%	162%	***	(2.37)
NLD	Netherlands	394%	323%	305%	377%	-18%		-(0.26)
NOR	Norway	362%	274%	373%	636%	273%		(1.45)
POL	Poland	591%	609%	450%	1893%	1302%	**	(2.04)
ESP	Spain	151%	173%	290%	301%	151%	***	(4.45)
CHE	Switzerland	112%	116%	145%	379%	267%	*	(1.80)
Mean		225%	216%	238%	508%	282%		

Panel B - Market model abnormal volume

Country code	Country name	Q1	Q2	Q3	Q4	Dif. 4-1		*t*-stat.
AUT	Austria	78%	62%	63%	138%	61%	**	(2.15)
BEL	Belgium	81%	80%	145%	242%	162%	***	(3.29)
DNK	Denmark	109%	118%	140%	356%	248%	***	(3.90)
FIN	Finland	298%	264%	275%	452%	154%	**	(1.97)
FRA	France	172%	245%	257%	648%	477%	***	(5.54)
DEU	Germany	88%	99%	140%	254%	165%	***	(9.33)
ITA	Italy	124%	117%	186%	273%	149%	**	(2.32)
NLD	Netherlands	292%	229%	275%	364%	72%		(1.11)
NOR	Norway	318%	201%	288%	433%	116%		(0.79)
POL	Poland	837%	427%	635%	1902%	1064%		(1.31)
ESP	Spain	88%	143%	243%	267%	178%	***	(6.58)
CHE	Switzerland	103%	88%	132%	279%	177%		(1.54)
Mean		216%	173%	232%	467%	252%		

*** $p<0.001$
** $p<0.05$
* $p<0.1$

Table 4
Estimated tax loss due to cum-ex trading

The table reports the total tax loss due to cum-ex trading estimated from both mean-adjusted abnormal trading volume and based on abnormal volume derived from a market model. The sample period is from January 2002 through August 2018.

		Estimated tax loss (in million EUR)	
Country code	Country name	Mean-adjusted abnormal volume	Market model abnormal volume
AUT	Austria	12	11
BEL	Belgium	87	82
DNK	Denmark	56	53
FIN	Finland	246	248
FRA	France	2,535	2,232
DEU	Germany	1,625	1,583
ITA	Italy	923	835
NLD	Netherlands	1,981	1,714
NOR	Norway	297	280
POL	Poland	22	25
ESP	Spain	2,518	2,240
CHE	Switzerland	297	279
Sum		10,599	9,582

Table 5

Regression analysis results of cumulative abnormal volume

The table reports results from a panel regression of cumulative abnormal trading volume measured over a three-day event window on dividend yield, *DY*, in Panel A and the following (control) variables in Panel B: *Post2013* is a time indicator, which is equal to 1 for all dividend events in the period 2013 to 2018 and 0 otherwise; *Post2013*DY* is an interaction term between dividend yield and the time indicator; *PDR* is the expected price drop ratio; *ACAP* measures firm size as the average market capitalisation over the estimation period;.β measures systematic and σ_e/σ_m unsystematic risk; and *TC* proxies for transaction costs defined as the inverse of the cum-dividend stock price. *T*-statistics are reported in brackets. The sample period is from January 2002 through August 2018.

Panel A

	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Poland	Spain	Switzerland
Intercept	3.2576***	3.8449***	3.0199***	3.7153***	3.0451***	3.0508***	5.3769***	3.8467***	4.3175***	3.2795***	4.4556***	3.2120***
	(20.573)	(13.247)	(8.146)	(5.195)	(22.894)	(26.038)	(11.784)	(17.839)	(12.358)	(8.794)	(18.126)	(17.011)
DY	0.0464	0.0511	0.5433***	0.5802***	0.3140***	0.3975***	0.1524*	0.2603***	0.0050	0.4530***	0.4339***	0.2213***
	(1.382)	(0.995)	(4.929)	(3.442)	(9.096)	(12.997)	(1.811)	(6.246)	(0.100)	(6.588)	(3.913)	(3.813)
Adj. R^2	0.002	0.001	0.017	0.006	0.013	0.032	0.001	0.020	0.000	0.023	0.010	0.005
Obs.	990	1414	1370	1877	6375	5142	2863	1949	1362	1871	1571	3040

Table 5 continued

Panel B

	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Poland	Spain	Switzerland
Intercept	3.4816***	3.4868**	4.4129**	5.5727***	3.1590***	4.0145***	4.9616***	4.5698***	5.8267***	4.7834***	5.7981***	3.8979***
	(4.875)	(2.365)	(2.287)	(3.259)	(6.873)	(6.050)	(3.071)	(5.788)	(3.656)	(3.423)	(7.145)	(4.877)
DY	0.1029**	0.0271	0.3954**	0.5725***	0.2092***	0.3705***	0.1260	0.3017***	-0.0068	0.2430***	0.5098***	0.0666
	(2.041)	(0.380)	(2.186)	(2.866)	(4.715)	(8.678)	(1.296)	(6.164)	(-0.098)	(2.581)	(3.726)	(0.746)
Post2013	0.2509	0.5793	-0.5577	-1.3489	-1.0028***	-0.6564**	-3.0186***	1.6880***	0.7603	-0.9314	-1.9977***	-0.2411
	(0.750)	(0.871)	(-0.662)	(-0.843)	(-3.272)	(-2.527)	(-3.021)	(3.481)	(0.968)	(-1.134)	(-3.721)	(-0.589)
Post2013*DY	-0.0208	-0.0162	0.0100	0.0213	0.4197***	0.1050	0.1498	-0.2720**	-0.0408	0.4773***	0.4102*	0.3341***
	(-0.281)	(-0.123)	(0.042)	(0.056)	(5.224)	(1.417)	(0.736)	(-2.523)	(-0.342)	(3.444)	(1.700)	(2.750)
PDR	0.1272***	-0.0000	-0.0002	0.0011	-0.0006	0.0030	-0.0001	-0.0053	0.0015	-0.0874	-0.0041	0.0020
	(2.803)	(-0.016)	(-0.017)	(0.132)	(-0.210)	(0.872)	(-0.068)	(-0.473)	(0.448)	(-1.580)	(-0.415)	(1.010)
ACAP	-0.0461	0.1182	-0.1716	0.0024	0.0489	0.0140	0.1752	-0.1270	-0.2925	-0.0302	0.1933**	-0.0064
	(-0.474)	(0.560)	(-0.627)	(0.011)	(0.836)	(0.154)	(0.855)	(-1.375)	(-1.389)	(-0.220)	(2.154)	(-0.067)
β	-0.6252	0.6516	-0.4656	-3.2407***	-0.8594***	-1.0892***	-2.3176**	-0.0812	-0.1663	-1.4367***	-1.4851***	-0.1249
	(-1.629)	(1.132)	(-0.640)	(-3.186)	(-3.431)	(-4.838)	(-2.412)	(-0.210)	(-0.431)	(-2.676)	(-4.285)	(-0.418)
$\sigma_\varepsilon/\sigma_m$	0.4428	-3.5077	5.8207	3.4363	1.7662	-3.3924**	14.1797**	-1.9797	1.8313	-1.3146	-8.6277***	-4.2648
	(0.207)	(-0.873)	(0.977)	(0.701)	(0.937)	(-2.444)	(2.035)	(-0.577)	(0.392)	(-0.177)	(-2.672)	(-1.530)
TC	-3.2008	-0.5200	-0.7495	-2.1561**	-0.5517	-0.8257	-0.6247	-0.0283	0.2324	-0.2903	-4.0710***	-0.6087
	(-1.405)	(-0.441)	(-1.172)	(-2.218)	(-1.128)	(-0.596)	(-0.925)	(-0.671)	(0.362)	(-1.467)	(-3.343)	(-0.521)
Adj. R^2	0.019	0.007	0.024	0.020	0.021	0.035	0.008	0.027	0.004	0.039	0.043	0.010
Obs.	990	1414	1370	1877	6375	5142	2863	1949	1362	1871	1571	3040

*** $p<0.001$
** $p<0.05$
* $p<0.1$

Table 6
First-stage OLS estimation results

The table reports results from an ordinary least squares estimation of dividend yield, *DY*, on the predicted price drop ratio, *PDR*. *T*-statistics are reported in brackets. The sample period is from January 2002 through August 2018.

	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Poland	Spain	Switzerland
Intercept	2.9965***	3.6941***	2.2508***	3.7474***	2.8974***	2.9743***	3.3971***	3.2394***	4.5153***	4.3848***	1.5986***	2.4198***
	(24.028)	(32.483)	(33.195)	(80.931)	(90.795)	(87.899)	(42.984)	(35.198)	(30.883)	(23.358)	(41.196)	(60.980)
DY	-0.1387***	-0.0008	-0.0028	-0.0034***	-0.0026***	-0.0045***	-0.0002	-0.0092	-0.0029	-0.0266*	0.0003	-0.0022***
	(-3.362)	(-1.024)	(-0.903)	(-2.994)	(-2.830)	(-3.003)	(-0.925)	(-1.506)	(-1.573)	(-1.829)	(0.144)	(-3.415)
Adj. R^2	0.011	0.001	0.001	0.005	0.001	0.002	0.000	0.001	0.002	0.001	0.000	0.004
Obs.	990	1414	1370	1877	6375	5142	2863	1949	1362	1871	1571	3040

*** p<0.001
** p<0.05
* p<0.1

Table 7

Regression analysis results of cumulative abnormal volume using orthogonalised DY

The table reports results from a panel regression of cumulative abnormal trading volume measured over a three-day event window on dividend yield, *DY*, which is orthogonal to the expected price drop ratio, *PDR*, in Panel A and the following (control) variables in Panel B: *Post2013* is a time indicator, which is equal to 1 for all dividend events in the period 2013 to 2018 and 0 otherwise; *Post2013*DY* is an interaction term between dividend yield and the time indicator; *ACAP* measures firm size as the average market capitalisation over the estimation period;.β measures systematic and $\sigma_{\varepsilon}/\sigma_m$ unsystematic risk; and *TC* proxies for transaction costs defined as the inverse of the cum-dividend stock price. *T*-statistics are reported in brackets. The sample period is from January 2002 through August 2018.

Panel A

	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Poland	Spain	Switzerland
Intercept	3.3906***	4.0336***	4.2405***	5.8846***	3.9533***	4.2304***	5.8943***	4.6864***	4.3398***	5.1265***	5.1493***	3.7453***
	(26.975)	(18.363)	(15.370)	(17.405)	(44.991)	(57.089)	(16.569)	(27.797)	(16.188)	(20.845)	(30.245)	(29.528)
DY_residual	0.0571*	0.0512	0.5429***	0.5829***	0.3139***	0.3971***	0.1524*	0.2598***	0.0054	0.4500***	0.4339***	0.2246***
	(1.692)	(0.995)	(4.924)	(3.450)	(9.088)	(12.971)	(1.810)	(6.230)	(0.108)	(6.541)	(3.913)	(3.864)
Adj. R^2	0.003	0.001	0.017	0.006	0.013	0.032	0.001	0.020	0.000	0.022	0.010	0.005
Obs.	990	1414	1370	1877	6375	5142	2863	1949	1362	1871	1571	3040

Table 7 continued

Panel B

	Austria	Belgium	Denmark	Finland	France	Germany	Italy	Netherlands	Norway	Poland	Spain	Switzerland
Intercept	3.8625***	3.8276***	5.3019***	6.7202***	3.7702***	5.1093***	5.3918***	5.5643***	5.7635***	5.7427***	6.6261***	4.0205***
	(5.659)	(4.013)	(2.912)	(2.909)	(8.666)	(7.949)	(3.450)	(7.447)	(3.850)	(4.310)	(8.377)	(5.451)
DY_residual	0.1157**	0.0602	0.3948**	0.5224**	0.2082***	0.3703***	0.1259	0.3020***	-0.0059	0.2455***	0.5087***	0.0718
	(2.300)	(0.993)	(2.185)	(2.370)	(4.698)	(8.684)	(1.296)	(6.170)	(-0.085)	(2.606)	(3.720)	(0.802)
Post2013	0.1017	1.0668**	-0.5354	-1.3005*	0.2143	-0.3440**	-2.5087***	0.7978**	0.5654	1.0816*	-1.3423***	0.5632**
	(0.388)	(2.250)	(-0.865)	(-1.661)	(1.076)	(-2.107)	(-3.275)	(2.074)	(0.950)	(1.837)	(-3.698)	(2.036)
Post2013*DY_residual	-0.0279	0.0007	0.0116	0.1146	0.4211***	0.1045	0.1498	-0.2748**	-0.0413	0.4627***	0.4127*	0.3259***
	(-0.377)	(0.006)	(0.049)	(0.288)	(5.240)	(1.413)	(0.736)	(-2.550)	(-0.346)	(3.345)	(1.712)	(2.678)
ACAP	-0.0163	-0.0142	-0.1724	0.2444	0.0472	0.0154	0.1742	-0.1289	-0.2846	-0.0553	0.1897**	-0.0003
	(-0.169)	(-0.106)	(-0.631)	(0.722)	(0.809)	(0.170)	(0.852)	(-1.397)	(-1.358)	(-0.406)	(2.125)	(-0.003)
β	-0.6877*	0.7033	-0.4638	-3.4266***	-0.8565***	-1.0915***	-2.3160**	-0.0813	-0.1623	-1.4137***	-1.4692***	-0.1330
	(-1.794)	(1.290)	(-0.638)	(-3.090)	(-3.422)	(-4.851)	(-2.411)	(-0.211)	(-0.421)	(-2.632)	(-4.269)	(-0.445)
$\sigma_{\varepsilon}/\sigma_{m}$	-0.1324	-2.6866	5.8400	1.6520	1.7770	-3.3849**	14.1949**	-2.0788	1.8097	-1.0389	-8.6057***	-4.1745
	(-0.062)	(-0.644)	(0.981)	(0.342)	(0.943)	(-2.439)	(2.038)	(-0.607)	(0.387)	(-0.140)	(-2.667)	(-1.498)
TC	-3.5340	-0.7003	-0.7496	-2.1694*	-0.5528	-0.8196	-0.6248	-0.0285	0.2322	-0.2960	-4.0792***	-0.6149
	(-1.554)	(-0.779)	(-1.174)	(-1.655)	(-1.131)	(-0.592)	(-0.926)	(-0.674)	(0.363)	(-1.496)	(-3.351)	(-0.527)
Adj. R^2	0.011	0.007	0.024	0.020	0.021	0.035	0.008	0.027	0.004	0.038	0.043	0.010
Obs.	990	1414	1370	1877	6375	5142	2863	1949	1362	1871	1571	3040

*** p<0.001
** p<0.05
* p<0.1