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Stock Market Behavior on Ex-Dividend Dates: The Case of Cum-Ex Transactions in Germany

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Abstract

This paper explores the effect of cum-ex trading on the stock market on ex-dividend dates. A loophole in the German withholding tax system until 2011 enabled cum-ex traders to achieve the issuance of withholding-tax certificates without previous withholding-tax payment. As the tax certificates could be used by a specific group of investors to obtain a tax deduction, this opened up the possibility of a specific form of tax arbitrage. The paper discusses the implications for the capital market equilibrium and derives empirical predictions for stock market behavior. The empirical analysis provides evidence using data on daily stock prices and volumes for German stocks listed in the HDAX index for the years 2009 to 2015. The identification strategy exploits variation in the withholding-tax liability of dividends. The results support a significant impact of cum-ex trading on price-drop ratios on ex-dividend dates indicating that the withholding tax loophole had a major capital market impact. Further, in line with reported cum-ex trading strategies, we find a statistically and economically significant increase in trading volumes by 55% and almost 100% on the two days prior to the ex-dividend date. In terms of policy implications, the results emphasize the importance of designing a consistent and effective withholding tax system.

Keywords: dividend taxes; capital gains taxes; price-drop ratio; ex-dividend dates; tax clienteles; tax evasion; withholding tax

JEL classification: H25, H26, G12

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1 Introduction

A large literature discusses the effects of capital income taxes on the stock market and on stock market behavior on ex-dividend dates (e.g., Elton and Gruber, 1970; Kalay, 1982; Michaely and Vila, 1995; McDonald, 2001). In particular, the literature focuses on withholding taxes on dividends as well as on capital gains taxes at the level of shareholder. With few exceptions, little attention is paid to the role of administrative procedures implemented to collect and enforce these taxes. However, depending on how the tax system is set-up, administrative procedure can play an important role. This is illustrated by a specific type of stock trades around dividend dates, that allegedly caused major tax losses in Germany.¹

Between January 2009 and December 2011, Germany imposed a withholding tax of 25% on dividend payments. Two separate agents were involved for tax collection and the issuance of tax certificates. While the withholding tax was collected by the dividend-paying corporation, the issuance of withholding-tax certificates was the responsibility of the stock holder's depository bank. This discrepancy created a lack of transparency in the withholding tax system that made it vulnerable for tax fraud: A new form of cum-ex trades was designed to achieve issuance of withholding-tax certificates without previous withholding-tax payment. These tax certificates were, however, de facto cash-equivalent as they entitled the owner to a tax deduction. Hence, their value opened up new profitable arbitrage opportunities for cum-ex trades. Since these tax certificates were issued without previous withholding-tax payment, the certified amount of withholding taxes directly constituted revenue losses for the public.²

This paper investigates the effects of cum-ex trading on the German capital market. We provide a theoretical discussion that shows how clandestinely operating cum-ex traders could

¹ While the tax administration has been revised recently, the federal parliament in Germany (Bundestag) has set up an investigation committee, to clarify why the loophole has not been closed earlier. (see Spengel and Eisgruber, 2015)

² Despite the obvious fact that one tax payment was associated with multiple certificates, various agents held that the construction was legal (for an overview, see Spengel and Eisgruber, 2015).

have substantially impacted the capital market. In particular, the theoretical analysis predicts a negative effect of cum-ex trading on the price-drop ratio at the ex-dividend day and a substantial positive effect on the trading volume around the ex-dividend day. We empirically test these theoretical predictions using an exceptional data set including price and trading-volume information on German stocks listed in the HDAX index for the years 2009 to 2015. Our empirical identification strategy exploits differences in the withholding-tax liability of dividend payments. Dividends that are paid from firms' current profits are subject to a 25% withholding tax (regular taxable dividends) and, therefore, principally suitable for cum-ex transactions. In contrast, dividends that are paid from firms' capital reserves are under the tax law at the time withholding-tax-free and, thus, unsuitable for cum-ex trading.

The empirical results show that during the cum-ex period, the ex-day price-drop ratio (PDR) in case of regular taxable dividends is, as theoretically predicted, significantly smaller than the PDR of withholding-tax-free dividends. In line with our theoretical model, we find the PDR of cum-ex suitable stocks to be statistically not significantly different from 0.75. The PDR of stocks not suitable for cum-ex trades is not statistically significantly different from 1. The difference in price-drop ratios becomes statistically insignificant in the time period after Januar 2012, when the German legislator had closed the loophole in the withholding system that enabled cum-ex trading. Furthermore, we find, as expected, a statistically highly significant increase in trading volume just within a two-day window before the ex-day. The increase is economically substantial: the trading volume increases due to cum-ex trading on the second day before the ex-day by 55% and on the day prior the ex-day by almost 100%. For dividend payments after the 2012 tax reform, we do not find any statistically significant difference in trading volume around the ex-day that can be attributed to the difference in withholding-tax liability of the dividend.

This paper contributes to the literature on the effects of taxation on the stock prices and trading volumes at ex-dividend dates. While previous studies used fundamental changes in tax systems over time as a source for empirical identification (e.g., Haesner and Schanz, 2013), we exploit for our analysis differences in the withholding-tax liability of dividends that created variation in the exposure of dividends to cum-ex trading. As cum-ex trading was in the legal limbo, the paper further provides evidence of market efficiency in the presence of costly arbitrage.³ The results in this article also provide evidence on broader issues, such as the importance of the design of tax systems (e.g., Slemrod and Gillitzer, 2014). In particular, it illustrates the potential vulnerability of withholding tax systems to tax fraud.

This paper proceeds as follows. Section 2 provides information on the background concerning cum-ex trading. Section 3 derives theoretical implications of cum-ex trading for the capital market equilibrium. Section 4 describes the data. Section 5 develops the empirical approach. Section 6 presents the empirical results. Section 7 concludes.

2 Background withholding tax system and cum-ex trades

Between January 2009 and December 2011, Germany requires German corporations to collect a withholding tax of 25% on dividend payments. Thus, in case of a dividend payment, the stock holder receives only 75% of the net dividend⁴ on her bank account. 25% of the net dividend are withheld by the corporation and directly transferred to the German government on account of the stock holder. While the withholding tax was collected by the dividend-paying corporation, the stock holder's depository bank was responsible for issuing the withholding-tax certificate. This discrepancy created a lack of transparency in the withholding tax system that made it

³ See for a previous study of a capital market equilibrium in the presence of costly arbitrage McDonald (2001). The author analyzes the German stock market at the end of the 1990's when foreign stock holders were trading a dividend tax credit and German authorities tried to prevent this behavior.

⁴ The net dividend is the dividend after corporate taxes.

vulnerable for tax fraud: A new form of cum-ex trades was designed to achieve issuance of withholding-tax certificates without previous withholding-tax payment. These tax certificates were, however, de facto cash-equivalent as they entitled the owner for a tax deduction. Hence, their value opened up new profitable arbitrage opportunities for cum-ex trades. Since these tax certificates were issued without previous withholding-tax payment, the certified amount of withholding tax constituted revenue losses for the public.⁵

The cum-ex trader instigates the cum-ex trade through a short-sale of a stock cum-dividend at price P_{CUM} one or two days before the ex-dividend date. The exact timing of the short-sale is important for cum-ex trades. As German stock market guidelines oblige the actual delivery of the stock within a two-trading-day window, the cum-ex trader achieves through this timing an ex-dividend delivery of the stock. The ex-dividend delivery at price P_{EX} is an essential part of cum-ex trades and necessary for the trades to be profitable.⁶

Once the stock sale is completed, the short-buyer immediately becomes the legal owner of the cum-dividend stock. Consequently, the buyer is legally entitled to receive a dividend payment. However, the stock will not have already been physically delivered to the buyer's depository account on ex-day (but one or two trading days later). Without further ado, the buyer will not receive a dividend payment. Hence, to ensure a correct dividend distribution, a so called dividend clearing is carried out. Important in the context of cum-ex trading is that the dividend clearing of German stocks is based on the dividend after withholding tax. In the clearing process, the short-buyer receives a "three-part delivery" that amounts to a value equal to the cum-dividend price, P_{CUM} , of the stock: The cum-ex trader delivers the stock ex-dividend at the price P_{EX} and pays a dividend compensation equal to the dividend after withholding tax,

⁵ Despite the obvious fact that one tax payment was associated with multiple certificates, various agents held that the construction was legal (for an overview, see Spengel and Eisgruber, 2015).

⁶ German stock-exchange rules require no coverage of the short-sale under the condition that delivery is completed within this two-trading-days window (§4 II Bedingungen für Geschäfte an der Frankfurter Wertpapierbörse), i.e. cum-ex transactions require no stock borrowing.

$(1 - \tau_d)D$. Further, the short-buyers' depository bank issues a withholding-tax certificate that confirms the payment of a withholding tax of $\tau_d D$. Hence, the short-buyer is indifferent between the delivery of stocks cum-dividend or the "three-part delivery" in the clearing process.

In this clearing process, the counter party, the cum-ex trader, makes only a "two-part delivery". According to the withholding tax rules at the time, the short-buyer's depository bank issues a withholding-tax certificate for the short-seller which, eventually, discharges the cum-ex trader from the obligation to fully deliver the value of the stocks cum-dividend. Consequently, the cum-ex trader earns a gross return equal to the withholding tax on the dividend payment, $\tau_d D$.

The issuance of withholding-tax certificates by depository banks for dividend compensation payments without actual withholding-tax payments is the consequence of a severe loophole in the withholding tax system at the time. Core of the problem is the fact that the withholding tax system defined different parties for the tax-withholding (the dividend-paying corporation) and the issuance of the tax certificate (depository banks). For depository banks it was, consequently, not transparent whether the underlying transaction was a cum-ex trade (without previous withholding tax payment) or an ordinary transaction (with previous tax payment). In both cases, the depository banks issued withholding-tax certificates. Cum-ex traders exploited this loophole. Presumably, organized large-scale cum-ex trading potentially caused large tax revenue losses for the German government between 2009 and 2011.

In January 2012, the German dividend withholding tax system was fundamentally reformed to prevent cum-ex trading. Most importantly, the discrepancy between the party withholding the dividend tax and the party issuing the tax certificate was eliminated. Since 2012, German depository banks are responsible for both the levying of the dividend withholding tax and the issuance of the withholding-tax certificate.

3 Theory

In this section, we derive a market equilibrium in which the trading behavior of investors in combination with the tax system gives rise to a price drop at the ex-dividend date (see, e.g., Allen and Michaely, 1995). We follow the approach by McDonald (2001) and Kalay (1982) and use a costly arbitrage framework to derive arbitrage conditions for the different risk-neutral investors operating at the stock market: individual, institutional, and corporate investors, broker dealers, and cum-ex traders. This allows us to establish a theoretical prediction of the equilibrium ex-dividend-day price-drop ratio both in the presence and absence of cum-ex transactions considering tax rules that applied during the time period January 2009 to January 2012.

3.1 Arbitrage strategies of investor classes

We derive arbitrage strategies for different investor classes and, further, distinguish on whether investors do already hold a stock or not. We start with the derivation of a general arbitrage condition for investors that do not already hold a stock. These investors have arbitrage opportunities from either buying the stock cum-dividend and selling it ex-dividend (long arbitrage strategy) or shorting the stock cum-dividend and closing the short position ex-dividend (short arbitrage strategy). Selling and buying at the stock market come at a transaction cost, c . The tax treatment enters with two tax instruments, a dividend tax, τ_D , and a tax on realized capital-gains, τ_g .

The expected return of an investor following a long-arbitrage strategy, which is buying a stock cum-dividend and selling the stock ex-dividend, is $(E[P_{EX}] - P_{CUM} - 2c)(1 - \tau_g) + D(1 - \tau_d)$. The long-arbitrage strategy yields an expected return that is smaller or equal to zero if the price-drop ratio exceeds or equals $\frac{P_{CUM} - E[P_{EX}]}{D} \geq \frac{1 - \tau_d}{1 - \tau_g} - \frac{2c}{D}$.

A short-arbitrage strategy would consist of borrowing and selling a stock cum-dividend and purchasing and returning the stock ex-dividend. This strategy yields an expected return of

$(P_{CUM} - E[P_{EX}] - 2c)(1 - \tau_g) - (1 + \gamma)(1 - \tau_d)D$ where $\gamma > 0$, a fraction of the net dividend, is the price for the stock borrowing. The expected return is non-positive if the price-drop ratio undercuts or equals $\frac{P_{CUM} - E[P_{EX}]}{D} \leq (1 + \gamma) \frac{1 - \tau_d}{1 - \tau_g} + \frac{2c}{D}$. Note that the equation represents the price-drop ratio in case of a *covered short-arbitrage strategy* as the short position is covered by the borrowed stocks.

To derive the market equilibrium, we use both equations to derive the general condition that ensures no profit opportunities in the market:

$$\frac{1 - \tau_d}{1 - \tau_g} - \frac{2c}{D} \leq \frac{P_{CUM} - E[P_{EX}]}{D} \leq (1 + \gamma) \frac{1 - \tau_d}{1 - \tau_g} + \frac{2c}{D}. \quad (1)$$

Next, we derive a general arbitrage condition for investors that already hold a stock. These investors could hold the stock over the dividend day which generates an expected return of $D(1 - \tau_d)$. Lending the stock to other investors facing a lower dividend tax yields $(1 + \gamma)D(1 - \tau_d)$ with $\gamma > 0$. It follows that investors should strictly prefer lending the stock to holding it. Alternatively, investors could follow a sale-repurchase strategy, selling the stock cum-dividend and repurchasing the stock ex-dividend, receiving a net return of $(1 - \tau_g)(P_{CUM} - E[P_{EX}] - 2c)$. The sale-repurchase strategy is preferred to holding the stock if

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq (1 + \gamma) \frac{(1 - \tau_d)}{(1 - \tau_g)} + \frac{2c}{D}. \quad (2)$$

Importantly, independent of whether investors already hold the stock or not, the acceleration or deceleration of transactions to capture or avoid dividends is an alternative arbitrage strategy, so-called implicit arbitrage (Michaely, 1991). In case of implicit arbitrage, transaction costs are considered irrelevant, $c = 0$, as transaction costs arise in any case, independent of the timing of

a transaction. We consider this strategy for small dividend yields when explicit arbitrage can be unprofitable due to relatively high transaction costs.

There is a variety of investors. The first investor class, **German fully taxable investors**, are broker dealers, institutional investors (e.g., financial institutions and insurers), corporate investors, and individual investors. German fully taxable investors face equal tax rates on dividends and realized capital gains, $\tau_g = \tau_d$. In case of individual investors, independent from the investment horizon, both capital gains and dividends are subject to a flat tax. German corporations benefit from basically tax-free dividends and capital gains.⁷ Institutional investors' and broker dealers' income from dividends and capital gains is subject to the standard corporate tax rate. From the perspective of **German fully taxable investors that do not already hold the stock**, arbitrage strategies are not profitable if the price-drop is within the interval

$$1 - \frac{2c}{D} \leq \frac{P_{CUM} - E[P_{EX}]}{D} \leq (1 + \gamma) + \frac{2c}{D}. \quad (3)$$

Note that the same condition equals for foreign corporate investors that do not already hold the stock and do not benefit from reduced tax rates.

German fully taxable investors that already hold the stock could sell the stock cum-dividend and repurchase it ex-dividend with an expected return of $(1 - \tau_g)(P_{CUM} - E[P_{EX}] - 2c)$. Alternatively, those investors with reduced tax rates on dividends and capital gains could hold the stock over the dividend day which yields an expected return of $D(1 - \tau_d)$. German fully taxable investors with **reduced tax rates on dividends and capital gains** avoid the dividend if

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq 1 + \frac{2c}{D}. \quad (4)$$

⁷ In case of German corporations, 5% of dividends and capital gains was declared as non-deductible expenses. Consequently, 95% of dividends and capital gains were tax-free (Scheffler, 2012).

German fully taxable investors with **full tax rates on dividends and capital gains** strictly prefer lending the stock over holding the stock, and earn, thereby, $(1 + \gamma)D(1 - \tau_d)$. The investors avoid the dividend if

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq (1 + \gamma) + \frac{2c}{D}. \quad (5)$$

During the time period 2009 to 2012, a particular group of investors operated on the stock market: **German long-term investors with a one-time exemption from capital-gains tax**. These investors had purchased stocks before the 1st of January 2009, had been holding the stocks for more than one year, and benefit, thus, from a one-time tax exemption on capital gains. The German long-term investors avoid the dividend as long as for the price-drop ratio holds

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq (1 - \tau_d) + \frac{2c}{D}, \quad (6)$$

otherwise they follow a sale-repurchase strategy that generates them a one-time tax-free capital gain.

Foreign corporate investors that hold the German stock are subject to the full dividend tax. Foreign corporate investors could, however, lend their stocks to German corporate investors that benefit from reduced rates on dividends and capital gains. The lending of the stock yields for foreign investors an expected net return of $(1 + \gamma)D(1 - \tau_{d,foreign})$ with $\gamma > 0$. Hence, foreign corporate investors should strictly prefer lending the stock to simply holding the stock which only yields $(1 - \tau_{d,foreign})D$. Alternatively, foreign investors could sell the stock cum dividend and repurchase the stock ex-dividend receiving a net return after foreign capital gains tax of $(1 - \tau_{g,foreign})(P_{CUM} - E[P_{EX}] - 2c)$. Assuming that $\tau_{d,foreign} = \tau_{g,foreign}$, on average, the sale-

repurchase strategy is preferred to lending the stock if

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq (1 + \gamma) + \frac{2c}{D}. \quad (7)$$

Note that the same condition holds for German fully taxable investors that hold a stock and do not profit from reduced tax rates.

Cum-ex traders are foreign, fully-taxable corporate investors. They follow an arbitrage strategy that exploits the loophole in the withholding tax system that leads to a tax certificate even though no withholding is paid. It generates an expected gross return that equals the amount of withholding tax on dividends, $\tau_d D$, which implies an expected net return of $(1 - \tau_{g,foreign})\tau_d D$. To exploit the loophole, it is crucial that a short-sale takes place within a two-trading-days window before the ex-day. German stock-exchange rules require no coverage of the short-sale under the condition that delivery is completed within this two-trading-days window, i.e. cum-ex transactions require no stock borrowing. The cum-ex trader closes the short position by two transactions. Firstly, the delivery of the stock ex-dividend at ex-dividend day. Secondly, as the requirement is delivery of a stock cum-dividend, the payment of a dividend compensation. This dividend compensation payment equals, according to the stock exchange clearing guidelines at the time, the net dividend, $(1 - \tau_d)D$. The net return from cum-ex trades is $(1 - \tau_{g,foreign})(P_{CUM} - P_{EX} - (1 - \tau_d)D - 2c)$. The cum-ex trader makes a marginal profit larger or equal to zero if

$$\frac{P_{CUM} - E[P_{EX}]}{D} \geq (1 - \tau_d) + \frac{2c}{D}. \quad (8)$$

3.2 Capital market equilibrium

The capital market equilibrium determines the ex-dividend day behavior of the stock prices considering the interaction between the investor groups. The model allows us to derive clear predictions for the effect of cum-ex trading on the marginal equilibrium price-drop ratios. In general, cum-ex trading should decrease the price-drop ratio significantly. While in the absence of cum-ex trading the model predicts a price-drop ratio equal to unity, in the presence cum-ex trading the expected marginal price-drop ratio is 0.75.

3.2.1 Marginal price-drop ratios in the absence of cum-ex trading

In a first step, we derive the equilibrium in the absence of cum-ex trading. Figure 1 summarizes the no-arbitrage conditions of the investor classes. The expected ex-dividend price drop in percent is plotted against the gross dividend yield. For dividend yields larger D^* , the equilibrium in absence of cum-ex trading is determined by the dividend capturing activities of German fully taxable investors (AB) until marginal zero profits. In equilibrium, the combination of dividend and ex-dividend price-drop should lie on the heavy dashed line, KL. The triangle KOL depicts possible equilibrium combination for small dividend yields in case of implicit arbitrage (McDonald, 2001). Hence, the average price-drop ratio, which represents the slope of the lines, should be slightly smaller than unity with a marginal price drop ratio of one. In the following, we explain the model characteristics in further detail to derive the stated equilibrium. The line OH illustrates the implicit arbitrage conditions for the German and foreign fully taxable investors. The parallel lines AB and CE illustrate the respective explicit arbitrage conditions (equations (3) and (4)). Below AB, the fully taxable German and foreign investors capture the dividend purchasing the stock cum-dividend and selling it ex-dividend. Above CE, these investors want to avoid the dividend and sell the stock. In the rectangle ABEC explicit arbitrage

is not profitable and only fully taxable German and foreign investors are implicitly trading. The line OM depicts the implicit arbitrage condition for the German long-term investors. The respective parallel line CF shows the explicit sale-repurchase condition for the long-term investors (equation (6)). For price-drop and dividend combination above CF, the long-term investor sells the stock cum-dividend and buys it ex-dividend. The same applies for the line OM, the implicit arbitrage condition. Below CF and OM, respectively, the German long-term investors try to capture the dividend by holding the stock. The stock loan fee γ is assumed to be relatively small such that the no-arbitrage equations (5) and (7) approximate to CE and OH, respectively. This assumption has only minor impact on the no-arbitrage equilibrium, as it results in an only slightly smaller shaded area KOL. For dividend yields larger D^* , the equilibrium is determined by the dividend-capturing activities of German fully taxable investors. Accordingly, dividend price-drop combinations should lie on the heavy dashed line, KL. The triangle KOL depicts the possible combinations of dividend and price-drop for relatively small dividend yields.⁸ In absence of cum-ex trading, the no-arbitrage equilibrium is summarized as follows. The regions I and IV give rise to one-sided markets where all investors try to either capture the dividend or avoid the dividend. Therefore, price-drop ratios in the regions I and IV cannot constitute the equilibrium. . In the regions II and III, long-term German investors sell the stock to fully taxable German and foreign investors, where marginal profits for all participants are larger than zero. Marginal profits for fully taxable investors equal zero when the combinations of dividend and price-drop lie on the heavy dashed line KB. The triangle KOL depicts the possible combinations of dividend and price-drop for relatively small dividends applying implicit arbitrage.

⁸ D^* is defined as the intersection point of, e.g., lines AB and OM which implies $D^*P_{cum} = \frac{2c}{\tau_d^*P_{cum}}$ in the case of implicit arbitrage (McDonald, 2001).

3.2.2 Marginal price-drop ratios in the presence of cum-ex

In a second step, we use the same model specifications to derive the equilibrium in the presence of cum-ex trading. Now, we assume the cum-ex trader characterizes the equilibrium which is the main difference compared to the prior model. For dividends larger D^* , the equilibrium in presence of cum-ex trading is determined by the stock selling activities of the cum-ex trader (CF) until marginal zero profits. Dividend/price-drop pairs should lie on the heavy dashed line LF. The triangle LOC depicts the possible price-drop/dividend pairs for small dividends in case of implicit arbitrage. Thus, the average price drop ratio in presence of cum-ex should be slightly larger than 0,75 with a marginal price drop ratio of 0,75. In the following section we explain the crucial differences compared to the prior model to derive the cum-ex trading equilibrium. Now, we add the cum-ex trading restriction in the graphic model. The line OM also depicts the implicit arbitrage strategy condition for the German long-term investors. The parallel line CF shows the explicit sale-repurchase condition for the long-term investors and the cum-ex trader, respectively (equation (6) and (8)). The stock loan fee γ is again assumed to be very small so that the no-arbitrage conditions of equations (5) and (7) approximating to CE and OH. The cum-ex trader (CF) can choose between selling the stock and doing nothing. Hence, the cum-ex trader sells the stock for dividend/price-drop pairs above CF running explicit arbitrage. The German long-term investor (OM and CF) can either hold the stock capturing the dividend or sale the stock to realize tax free capital gain profits. This tax exemption only applies once giving up this tax exemption on future capital gains. The long-term investor therefore is not to be assumed the marginal investor. In region II and III the long-term investor avoids the dividend who permanently gives up the stock position. The fully taxable German and foreign investor (AB) captures these dividends in region II and III, respectively. The cum-ex trader sells the stock in region III until the dividend/price-drop pairs lie on the heavy dashed line PF

resulting in marginal profits equal zero. In the section LP, fully taxables capture the dividend by accelerating/decelerating their already planned transactions (OH). They cannot run explicit arbitrage (AB) due to the minor offering of stocks by the long-term investors (OM). Therefore, the equilibrium should be stated by the section LP. The shaded area LOC depicts the possible price-drop/dividend pairs for small dividends. Fully taxable German and foreign investors run implicit arbitrage capturing the dividend for price-drop/dividend pairs below OL and avoiding dividends above OL. For price-drop/dividend combinations above CL, the cum-ex trader would apply explicit arbitrage by selling the stock.

3.3 Empirical predictions

Cum-ex trades were particularly designed to achieve the issuance of withholding-tax certificates without previous withholding-tax payment. These achieved tax certificates are cash-equivalent and their value equals the profit from cum-ex trades. The German tax law, however, does not subject all dividend payments to withholding taxes. Whereas dividends paid from firms' current profit are subject to a 25% withholding tax (in the following regular taxable dividends), dividends paid from firms' capital reserves are withholding-tax-free (in the following withholding-tax-free dividends).⁹ Cum-ex trading is only profitable with stocks paying dividends from their current profits that are subject to withholding tax, as only in this case the cum-ex trader can achieve the issuance of a withholding-tax certificate. This enables us to use stocks paying withholding-tax-free dividends as control group to analyze the effect of cum-ex trading on capital market outcomes.

⁹ Dividends paid from capital reserves are withholding-tax-free according to §27 KStG (Corporation Tax Act). The withholding-tax-free dividend reduces the initial purchasing price of the stock and, thereby, increases the investor's capital gain.

According to the capital market model, in the presence of cum-ex trading, the marginal price-drop ratio should be smaller as compared to the price-drop ratio in the absence of cum-ex trading. This leads us to our first hypothesis:

H1: In the presence of cum-ex transactions the marginal price-drop ratio of stocks paying regular dividends is significantly smaller than the marginal price-drop ratio of stocks that pay withholding-tax-free dividends.

The equilibrium in the capital market model makes precise predictions with respect to the size of the marginal price-drop ratios:

H2: In the presence of cum-ex trading, the expected ex-dividend day price-drop ratio for stocks paying regular taxable dividends is 0.75.

H3: In the presence of cum-ex trading, stocks paying withholding-tax-free dividends show an expected ex-dividend day price-drop ratio of one.

In January 2012, the German legislator reformed the withholding-tax-system to prevent cum-ex trading. For the period after January 2012, we expect no statistically significant difference in marginal price-drop ratios that results from differences in the withholding-tax liability of dividend payments:

H4: The difference between the marginal price-drop ratio of stocks paying regular taxable dividends and stocks that pay withholding-tax-free dividends is not significantly different from zero after 2011.

Cum-ex trading should lead to increased trading activity at stock exchanges around the ex-day. We expect the cum-ex traders to execute a large number of short-sales within a two-day window before ex-dividend day of a stock. Through the timing of the short-sales within the two-day window, the cum-ex trader ensure a ex-dividend delivery of the stock which is crucial for the trade to be profitable. Notably, there are alternative theories such as the dynamic trading

cliente theory (Michaely and Vila, 1995) that also predict increased trading activity around the ex-dividend day. To distinguish the general increase in trading volume around the ex-day from the cum-ex effect, we, again, refer to our control group of stocks paying withholding-tax-free dividends:

H5: For stocks paying regular taxable dividends, the increase in trading volume in the two-day window prior to the ex-day is significantly higher than the increase in trading volume of stocks that pay withholding-tax-free dividends.

The reform of the withholding-tax system in 2012, should also affect the trading volumes around German stocks ex-day:

H6: The difference in the trading volumes within the two-day window prior to the ex-day that results from a different withholding-tax liability of dividends should disappear after January 2012.

4 Data

We analyze the effects of cum-ex trading on price-drop ratios and trading volumes of German stocks that are included in the German HDAX index between 2003 and 2015.¹⁰ The focus of the cum-ex analysis is on regular dividend payments, i.e. capital bonuses are excluded. Information on absolute dividend payments (adjusted for stock splits) and dividend payment dates is taken from the Thomson Reuters EIKON database. Our empirical strategy exploits variation in the withholding-tax liability of dividends, i.e. withholding-tax-exempt stocks did not qualify for cum-ex trading. Thus, we categorize dividend payments into withholding-tax-exempt dividends¹¹ and regular taxable dividends using information on the withholding-tax liability of

¹⁰ The HDAX index includes the 110 German stocks that are largest in terms of their market capitalization. It covers the substantial part of German exchange listed stocks with approximately 96% of the stocks listed in the broader CDAX index.

¹¹ Dividends paid out of a corporation's capital reserve are withholding tax free according to §27 KStG (Corporation Tax Act) withholding tax free. Such dividend payments can be seen as a capital reduction.

the dividend in German corporations' annual official dividend announcements provided by the Bundesanzeiger.

To calculate price-drop ratios, we gather information on daily unadjusted closing prices, total return indices and the HDAX market index based on XETRA values from Thomson Reuters EIKON. To analyze the effects of cum-ex trading on trading volumes, we use information on daily trading volumes in the years 2009 to 2015 which are provided by the Karlsruhe Institute of Technology (KIT) as part of the Karlsruher Kapitalmarktdatenbank (KKMDB). A feature of the KIT database worth mentioning is that it includes comprehensive information on trading volumes at all German stock exchanges including OTC markets. Free float weighted market capitalization is obtained from Thomson Reuters EIKON.

5 Methods

We aim at estimating the effect of cum-ex trading on the ex-day price-drop ratio. For that purpose, we use linear regression models to estimate the following equation:

$$\text{relative price drop}_{it} = \beta_0 + \beta_1 I_{\text{profit},it} + \beta_2 I_{\text{profit},it} * \text{dividend yield}_{it} + \beta_3 \text{dividend yield}_{it} + \varepsilon_{it}. \quad (9)$$

The dependent variable, relative price drop_{it}, is the drop in stock *i*'s price from the cum-day (day *t* − 1) to the ex-day (day *t*), relative to the cum-day price.¹² *I*_{profit,it} is a binary indicator that equals unity if the dividend source is the current profit and zero in case dividends are paid from capital reserves. The dividend yield, dividend yield_{it}, is the net dividend relative to the cum-day price. We are interested in the coefficients β_2 and β_3 . The latter captures the marginal price-

¹² To prevent bias due to market developments, we adjust the cum-price by the expected daily return according to Elton et al. (2005). The expected daily return is estimated using a market model. The estimation period covers a time window of 120 days around the ex-day, where 5 days before and 5 days after the ex-day are excluded.

drop ratio in the absence of cum-ex trading. We estimate β_3 from a group of dividends that are withholding-tax-free and, therefore, not suitable for cum-ex trading. β_2 describes the difference in the marginal price-drop ratio that results from cum-ex trading. We derive the estimate β_2 from dividends that are subject to withholding tax and, therefore, principally suitable for cum-ex trading. The sum $\beta_2 + \beta_3$ is the marginal price-drop ratio in the presence of cum-ex trading. The coefficient β_0 is the intercept of the regression equation for withholding-tax-free dividends. β_1 measures the deviation in the intercept between the two groups. ε_{it} is an idiosyncratic error.

Further, we aim to evaluate the effect of cum-ex trading on the daily trading volume around the ex-day. We use linear regression models to estimate the following equation:

$$\log \text{volume}_{it} = \lambda_0 + \lambda_1 I_{\text{profit},it} + \lambda'_2 D_t + \lambda'_3 D_t * I_{\text{profit},it} + \varepsilon_{it} \quad (10)$$

The dependent variable, volume_{it} , describes the number of stocks i traded at day t , where t is a day within a 120-day window around i 's ex-day. Again, $I_{\text{profit},it}$ is a binary indicator that equals unity if the dividend source is the current profit (regular taxable dividend) and zero in case dividends are paid from capital reserves (withholding-tax-free dividend). D_t is a vector of indicators that mark each of the five days before and after the ex-day.

Based on the comparison with our control group of withholding-tax-free dividends, we estimate the abnormal trading volume caused by cum-ex trading in the days around the ex-day. For the control group of withholding-tax-free dividend payments, the coefficients in the vector λ_2 show the difference in trading volume at the 10 days around the ex-day compared to ordinary trading days. The coefficients in the vector λ_3 capture the cum-ex effect on the trading volume (relative to the control group) for each of the 10 days around the ex-day. λ_0 is a constant term. λ_1 measures the average difference in trading volume between the two groups of stocks on ordinary trading days while we define ordinary trading days to be within a 120-day window around

the ex-day excluding the 5 days before and the 5 days after the ex-date. ε_{it} is an idiosyncratic error.

We apply pooled OLS regressions to estimate both regression equations. Robust standard errors are clustered at the level of the stock to take account of heteroscedasticity in the linear regression models and to allow for possible within correlation in the error. The key identifying assumption for pooled OLS regressions is that the estimated difference in price-drop ratios/trading volume is entirely attributable to cum-ex trading. To strengthen this assumption, we run regressions, besides for the cum-ex period from 2009 to 2011, also for the post period from 2012 to 2015 where we do not expect to find any statistically significant difference in the price-drop ratios/ trading volumes that results from differences in the withholding-tax-liability of dividends.

6 Empirical results

6.1 Ex-day price-drop ratios

This subsection presents empirical evidence on the question of whether cum-ex-trading affects the ex-day price-drop ratio. Table B1 reports the OLS estimation results for the marginal price-drop ratios for the cum-ex period (2009-2011) and the post period (2012-2015). The first column presents estimates for the marginal price-drop ratios for the cum-ex period. In the absence of cum-ex trading under the tax-system at the time, we expect the marginal price-drop ratio to be equal to one. To test this theoretical prediction, we exploit the fact that withholding-tax-exempt stocks are not suitable for cum-ex trading.

The point estimate for the price-drop ratio of withholding-tax-exempt stocks is 1.20. It is not significantly different from one (F-test with p-value=0.227). In the presence of cum-ex trading, we expect the marginal price-drop ratio to be significantly smaller than one with a

lower boundary of 0.75. At a price-drop ratio of 0.75 the cum-ex trader makes zero marginal profit. The point estimate of the marginal price-drop ratio of cum-ex suitable stocks is 0.75. Importantly, the point estimate is statistically significantly different from one (F-test with p-value=0.002).

Column 2 of Table B1 presents the results for the period after January 2012, when the German legislator prevented cum-ex trading with a reform of the tax law. For this post period, we find no statistically significant difference in the price-drop ratios that can be explained by difference in the withholding-tax liability of dividends.

6.2 Trading volumes

Table B2 reports evidence on how cum-ex trading affects the trading volumes at German stock exchanges around the ex-day. Column 1 presents OLS regression results for the abnormal trading volume at each day within a ten-day window around the ex-dividend day during the cum-ex period. The dependent variable is defined as the natural logarithm of a stock's daily trading volume aggregated over all German stock exchanges. We, therefore, interpret the coefficients as marginal changes in trading volume in %. For dividends that are withholding-tax exempt, the point estimates generally indicate that the trading volume statistically significantly increases by between 24% and 43% the three days before dividend payment and the ex-day itself. Interestingly, stocks that are cum-ex suitable statistically significantly exceed these increases precisely at the two days prior to the ex-day. The two-day window before the ex-day is crucial for cum-ex trading. Within this two-day window, the cum-ex traders shorten the stocks at the cum-dividend price. Cum-ex trading, therefore, increases the trading volume on day -2 by approximately 55%, on day -1 by approximately 94%. Hence, the largest part of cum-ex trading happens on the day prior to the ex-day.

In the literature, it has so far not been entirely clear how cum-ex traders closed their open positions (for a discussion see, e.g., Deutscher Bundestag, 2014). Interestingly, our regression results show no statistically significant difference in trading volumes neither on the ex-day nor on the five subsequent days. This indicates that cum-ex traders seem not to close their positions with stock purchases at the stock exchanges but rather choose alternatives. This may be stock loans, for instance.

Column 2 in Table B2 provides further results that strengthen the validity of our identification strategy. It measures the effect of cum-ex trading on trading volumes. In the post period, the point estimates show at no day within the ten-day window around the ex-day a statistically significant difference in trading volumes that results from the difference in withholding-tax liability of dividends.

7 Conclusion

This paper analyzed the consequences of a major loophole in the tax system in case of withholding taxes on dividends. We provided a theoretical discussion that shows how clandestinely operating cum-ex traders that exploit the loophole could have substantially impacted the capital market. In particular, the theoretical analysis predicts a negative effect of cum-ex trading on the price-drop ratio at ex-dividend day and a substantial positive effect on the trading volume around the ex-dividend day. We empirically test these theoretical predictions using an exceptional data set including price and trading-volume information on German stocks listed in the HDAX index for the years 2009 to 2015. Our empirical identification strategy exploits differences in the withholding-tax liability of dividend payments. Dividends that are paid from firms' current profits are subject to a 25% withholding tax (regular taxable dividends) and, therefore, principally suitable for cum-ex transactions. In contrast, dividends that are paid from firms'

capital reserves are under the tax law at the time withholding-tax-free and, thus, unsuitable for cum-ex trading.

The empirical results show that during the cum-ex period, the price-drop ratio at ex-dividend dates in case of regular taxable dividends is, as theoretically predicted, significantly smaller than the price-drop ratio of withholding-tax-free dividends. In line with our theoretical model, we find the price-drop ratio of cum-ex suitable stocks to be statistically not significantly different from 0.75. The price-drop ratio of stocks not suitable for cum-ex trades is not statistically significantly different from 1. The difference in price-drop ratios becomes statistically insignificant in the time period after January 2012, when the German legislator had closed the loophole in the withholding system that enabled cum-ex trading. Furthermore, we find, as expected, a statistically highly significant increase in trading volume just within a two-day window before the ex-day. The increase is economically substantial: the trading volume increases due to cum-ex trading on the second day before the ex-day by 55% and on the day prior the ex-day by almost 100%. For dividend payments after the 2012 tax reform, we do not find any statistically significant difference in trading volume around the ex-day that can be attributed to the difference in withholding-tax liability of the dividend.

This paper contributes to the literature on the effects of taxation on the stock prices and trading volumes at ex-dividend dates. While previous studies used fundamental changes in tax systems over time as a source for empirical identification (e.g., Haesner and Schanz, 2013), we exploit for our analysis differences in the withholding-tax liability of dividends that created variation in the exposure of dividends to cum-ex trading. As cum-ex trading was in the legal limbo, the paper further provides evidence of market efficiency in the presence of costly arbitrage. In terms of policy implications, the results emphasize the importance of designing a consistent and effective withholding tax system.

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Appendix

Supplementary material for

**“Stock Market Behavior on Ex-Dividend Dates:
The Case of Cum-Ex Transactions in Germany”**

A Figures

Figure A1
Average volume of stocks traded per day (all German stock exchanges, 2009 - 2015)

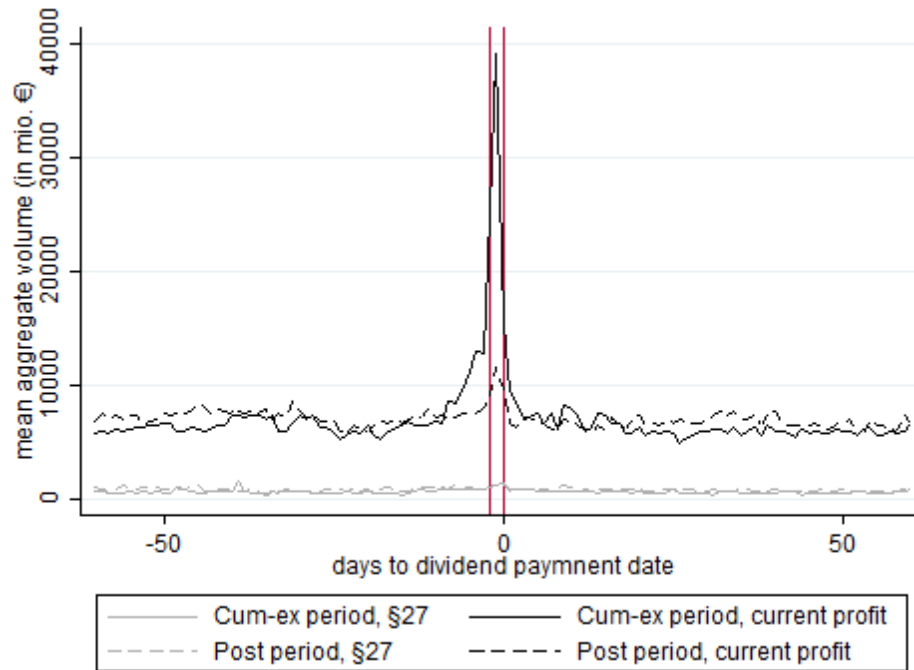
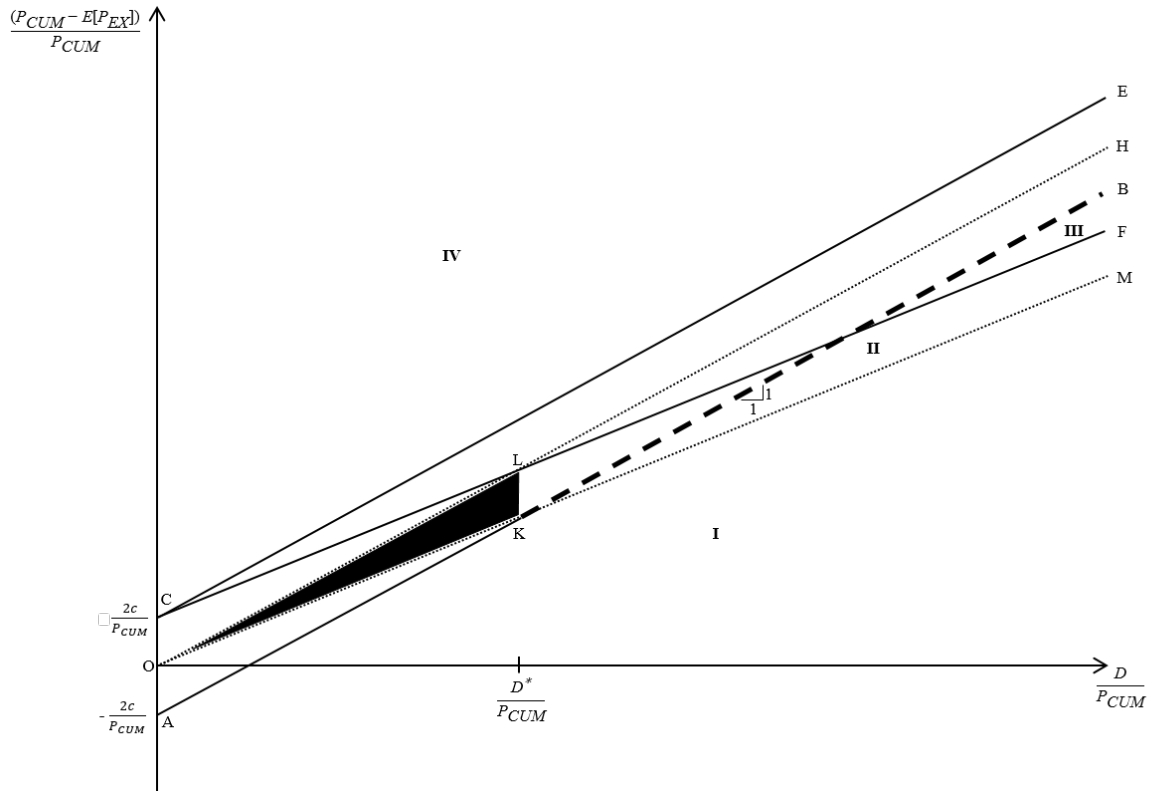
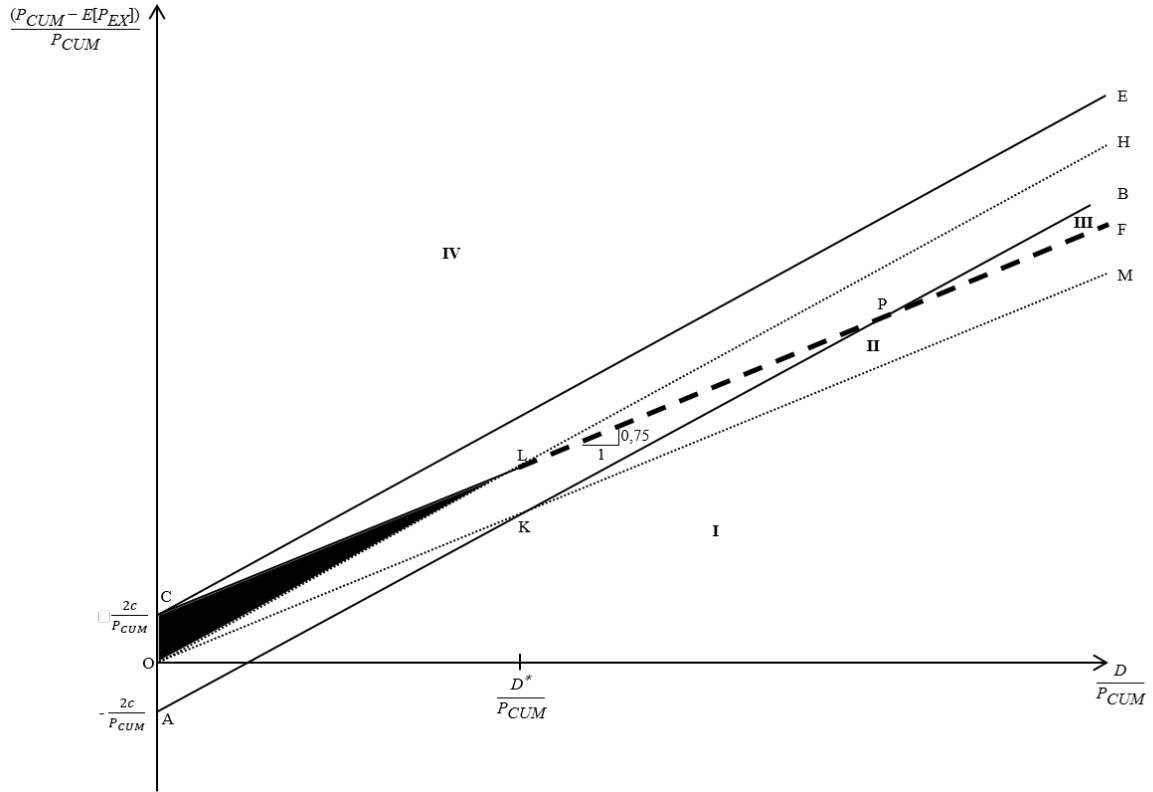


Figure A2
Capital market equilibrium in the absence of cum-ex trading



Note: The figure presents the no-arbitrage equilibrium for different investor classes in absence of cum-ex trading. The expected ex-dividend price drop in percent is plotted against the gross dividend yield. The line OH illustrates the implicit arbitrage conditions for German and foreign fully taxable investors. The parallel lines AB and CE illustrate explicit arbitrage conditions for the fully taxable investors (equations (3) and (4)). The line OM depicts the implicit arbitrage strategy condition for the German long-term investors. The respective parallel line CF shows the explicit sale-repurchase condition for the long-term investors (equation (6)). The stock loan fee γ is assumed to be very small such that the no-arbitrage conditions of equations (5) and (7) approximate to CE and OH, respectively. For dividend yields larger D^* , the equilibrium is determined by the dividend capturing activities of German fully taxable investors until marginal zero profits. In equilibrium, dividend-price-drop pairs should lie on the heavy dashed line KL. The triangle KOL depicts possible equilibrium dividend-price-drop pairs for small dividend yields in case of implicit arbitrage (McDonald, 2001).

Figure A3
Capital market equilibrium in the presence of cum-ex trading



Note: Figure 2 presents the no-arbitrage equilibrium for different investor classes in the presence of cum-ex. The expected ex-dividend price drop in percent is plotted against the gross dividend yield. The line OH illustrates the implicit arbitrage conditions for German and foreign fully taxable investors. The parallel lines AB and CE illustrate the respective explicit arbitrage conditions (equations (3) and (4)). The line OM depicts the implicit arbitrage strategy condition for the German long-term investors. The parallel line CF shows the explicit sale-repurchase condition for the long-term investors and the cum-ex trader (equation (6) and (8)). The stock loan fee γ is assumed to be very small so that the no-arbitrage conditions of equations (5) and (7) approximating to CE and OH, respectively. For dividends larger D^* , the equilibrium is determined by the stock selling activities of the cum-ex trader until marginal zero profits. Dividend/Price-drop pairs should lie on the heavy dashed line LF. In the section LP, fully taxable German and foreign investors capture the dividend by accelerating/decelerating their already planned transactions. The shaded area LOC depicts the possible dividendprice-drop pairs for small dividend yields. Fully taxable German and foreign investors follow implicit arbitrage strategies and capture dividends for dividendprice-drop/dividend pairs below OL (avoid dividends for pairs above OL). For dividendprice-drop pairs above CL, the cum-ex trader would follow explicit arbitrage selling the stock.

B Tables

Table B1
Regression results: Ex-dividend day price-drop ratios

Mean price-drop ratio (PDR)	Cum-ex period	Post period
Dividend source: Current profit	0.75	0.76
95% confidence interval	[0.60;0.91]	[0.61;0.91]
(p-value, H0: Mean PDR = 1)	(0.002)	(0.001)
(p-value, H0: Mean PDR = 0.75)	(0.961)	(0.912)
Dividend source: Capital reserves (§27 KStG)	1.20	0.85
95% confidence interval	[0.88;1.53]	[0.67;1.03]
(p-value, H0: Mean PDR = 1)	(0.227)	(0.112)
(p-value, H0: Mean PDR = 0.75)	(0.007)	(0.265)
Observations	301	439

Note: The table includes mean ex-day price-drop ratios of stocks that pay dividends either from current profit or from capital reserves. Mean price-drop ratios are presented cum-ex period from 2009 to 2011 and the post-period from 2012 to 2015, separately. Dividends from current profit are subject to withholding tax and, therefore, suitable for cum-ex trading. Dividends from capital reserves are withholding-tax-free and, thus, not suitable for cum-ex trading. The mean price-drop ratios describe the relation between the relative ex-day price drop, defined as $\frac{P_{EX}-P_{CUM}}{P_{CUM}}$ and the stock's dividend yield. P-values are presented in parentheses. Standard errors are clustered at the stock-level. The sample includes all stocks that are constituents of the HDAX index between 2003 and 2015. Stocks with dividend yields below the 10% percentile of the dividend-yield distribution are excluded from the sample.

Table B2
Regression results: Abnormal trading volume around the ex-dividend day

Day	Dividend type	Cum-ex period		Post-cum-ex period	
		Coef.	p-value	Coef.	p-value
-5	Dividend source: Current profit	.1254705	(0.433)	-.1748591	(0.239)
	Dividend source: Capital reserves (§27 KStG)	.0083214	(0.955)	.1439423	(0.281)
-4	Dividend source: Current profit	.1607902	(0.414)	-.0404516	(0.656)
	Dividend source: Capital reserves (§27 KStG)	.0603509	(0.750)	.1662504	(0.040)
-3	Dividend source: Current profit	.0184038	(0.881)	-.176799	(0.119)
	Dividend source: Capital reserves (§27 KStG)	.2422808	(0.025)	.2039075	(0.041)
-2	Dividend source: Current profit	.2249511	(0.046)	-.0232361	(0.800)
	Dividend source: Capital reserves (§27 KStG)	.2996999	(0.000)	.2319899	(0.007)
-1	Dividend source: Current profit	.59813	(0.003)	-.0028579	(0.974)
	Dividend source: Capital reserves (§27 KStG)	.3369503	(0.045)	.2849426	(0.000)
0	Dividend source: Current profit	.2032454	(0.120)	-.1270521	(0.177)
	Dividend source: Capital reserves (§27 KStG)	.4322077	(0.000)	.4285803	(0.000)
1	Dividend source: Current profit	-.0116622	(0.934)	.0828322	(0.375)
	Dividend source: Capital reserves (§27 KStG)	.1502249	(0.213)	-.0639553	(0.397)
2	Dividend source: Current profit	-.0062259	(0.957)	-.1537719	(0.078)
	Dividend source: Capital reserves (§27 KStG)	.1592874	(0.116)	.0930946	(0.135)
3	Dividend source: Current profit	.03744	(0.780)	.0391098	(0.663)
	Dividend source: Capital reserves (§27 KStG)	.0440458	(0.717)	-.0567228	(0.480)
4	Dividend source: Current profit	-.0556253	(0.675)	-.0363631	(0.598)
	Dividend source: Capital reserves (§27 KStG)	.1349402	(0.270)	.0048747	(0.932)
5	Dividend source: Current profit	.0324312	(0.773)	-.1610728	(0.119)
	Dividend source: Capital reserves (§27 KStG)	.0506961	(0.522)	.1237609	(0.187)
ordinary	Dividend source: Current profit	-.2804637	(0.610)	-.622347	(0.147)
ordinary	Dividend source: Capital reserves (§27 KStG)	12.84816	(0.000)	13.20428	(0.000)
Observations		39,037		60,045	

Note: The dependent variable is defined as the natural logarithm of a stock's daily trading volume aggregated over all German stock exchanges. We distinguish stocks by whether the source of dividend payments current profits or capital reserves. The cum-ex period comprises the years 2009 to 2011, the post-period the years 2012 to 2015. Dividends from current profit are subject to withholding tax and, therefore, suitable for cum-ex trading. Dividends from capital reserves are withholding-tax-free and, thus, not suitable for cum-ex trading. P-values (based on robust standard errors clustered at the stock-level) from test on statistical significance are presented in parentheses. The sample includes all stocks that are constituents of the HDAX index between 2003 and 2015.