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What Drives the Devil's Machine?

An empirical study on dividend withholding taxes, settlement changes, and legislative changes' effect on trading around the ex-dividend date in European markets.

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Abstract

This thesis explores the dividend withholding tax (DWT) schemes related to changes in the general DWT rate, the effect of imposing a DWT on investors, settlement cycles, and legislative measures to limit the DWT schemes.

Through our analyses of 14 different countries from 2004 to 2020, we have found no significant effect on abnormal volume caused by the changes in the general DWT rate. This contrasts our hypothesis; that higher general DWT rates will lead to a higher level of abnormal volume caused by DWT schemes. However, we find significant increases in excess volume when a DWT is imposed on the investors.

We also included two supplementary research problems: The effect on abnormal volume caused by a transition from T+3 to T+2 standard settlement cycle is inconclusive. Our analysis provides no new insights into DWT schemes when analysing excess volume before and after the transition.

The countries that have between 2004 and 2020 implemented legislative measures to combat DWT schemes generally seem to have achieved the desired effect. All countries except Denmark, Norway and Switzerland show a significant decrease in abnormal volume following the new regulatory framework.

Contents

1 Introduction

This thesis investigates trading schemes related to the dividend withholding tax, costing European taxpayers a substantial amount in recent decades. Facilitators of the schemes include major European banks that, through legal and regulatory loopholes, circumvent the tax paid by certain investors, consequently shifting the tax burden onto other members of society. Furthermore, some of the facilitating banks were bailed out by treasuries during the financial crisis of 2008. The schemes provided near risk-free profits derived from European treasuries; one of the former participants fittingly labelled the schemes as "The Devil's Machine" when speaking to Segal (2020) of the New York Times.

1.1 Background

Correctiv (2018), a cross country collaboration of 38 journalists, revealed one of the biggest tax scandals of modern times to the public with the release of a series of articles; the Cum-Ex Files. The investigation claimed that European taxpayers had been defrauded for over €55 billion between 2001 and 2012. However, more recent investigations indicate an even higher loss the treasuries that exceeds €100 billion and over a larger geographical area than those covered in the cum-ex files, including countries not mentioned in the initial investigation (Zoutman, 2019; ESMA, 2020).

The Cum-Ex Files uncovered how agents in the financial sector would utilise strategies that involved sophisticated schemes that involved change of ownership around the ex-date. Sometimes using technically legal methods, they would either avoid paying taxes or, in the more severe cases, receive multiple tax reimbursements on one single tax payment (Correctiv, 2018). The particular methods addressed by the cum-ex files are called cum-cum and cum-ex, which we will describe in more detail in Section 2. These kinds of trading schemes can collectively be defined as dividend arbitrage strategies focused on tax extraction or avoidance related to the dividend withholding tax (DWT), which we refer to as "DWT schemes" for the remainder of this thesis.

The first reported cases of DWT schemes dates back to 2001 with the German state tax auditor Hanno Berger, also commonly known as Mr Cum-Ex, as one of the key instigators of the scheme (Doctorow, 2020). In many jurisdictions, it is difficult to determine the legality of the DWT schemes for several reasons. The DWT schemes operate in the intersection between financial markets and tax regulations, and the communication between the financial and tax authorities is often imperfect, both within and between countries. The competent authorities fail to delegate to which of the two institutions the problem should be addressed, which have prolonged the process of eliminating the institutional flaws that enable DWT schemes (ESMA, 2020). As a result of the scandal, several European countries have taken legislative steps to minimise the DWT schemes. The European Banking Authority recently released a ten-point action plan to enhance the future regulatory framework to curtail dividend arbitrage trading by amending cross border guidelines on the governance of banking institutions. These guidelines will be in full effect by the end of 2021. (European Banking Authority, 2020a). The nature of these schemes is that the colluders operate in the shadows and design the DWT schemes to create difficulties for the competent authorities in keeping track of how the colluders overcome and adapt to existing and new legislation.

As we will cover in Section 2, much of the existing research on DWT schemes have been focused, primarily in Germany, on determining the presence of dividend arbitrage collusion and the effectiveness of legislative measures on reducing these types of trades. We attempt to better understand the DWT schemes by looking at the effect of imposing a DWT, what effect changes in general DWT rate, the effect of changes in the settlement cycle the and the effect of reforms to curtail DWT-schemes has on abnormal volume within the window of opportunity for the schemes. The existing research on investors behaviour around ex-dividend day has been focused on differences between domestic investors. However, the rapid globalisation of capital markets has made international investors and cross border trading more important in recent decades. As an example, foreign ownership of publicly traded equities in the United Kingdom has increased from 4% to 54% between 1980 and 2017 (Tang et al., 2019), and similar trends also exist in the other European markets.

1.2 Research Questions

This thesis wishes to place the DWT schemes related to dividend withholding taxes within the existing theoretical framework. Further, we want to look at what effect having a DWT has on trading around the ex-date and what effect changes in the general DWT rate has on the level of trading around ex-dividend day. We also want to investigate if the harmonisation of European settlement cycles to a T+2 standard can indicate the scope of these trading schemes around ex-dividend day by looking at the difference in trading patterns around the ex-date with different standard settlement cycles. We will look at the relationship between change in the general DWT rates and abnormal trading through these investigations. We also investigate how trading patterns change after the introduction of a T+2 standardisation of the settlement cycle. In addition, we also want to both control for and test for the effect of legislative changes that directly target DWT schemes. There are many reasons for abnormal trading around ex-date unrelated to DWT. A challenge for our analysis is to isolate these effects from DWT schemes.

Research Questions:

1. *Does having a dividend withholding tax lead to a higher trading volume around the ex-date?*
2. *Do increases in the general dividend withholding tax lead to a higher trading volume around the ex-date?*
3. *Have the transition from a T+3 to a T+2 settlement cycle led to changes in excess trading three days before the ex-date?*
4. *Have recent legislative attempts to limit or eliminate DWT schemes been successful?*

To answer these questions, we will analyse the volume around dividend distributions in selected European countries. Through pooled OLS models developed in Section 4, we will investigate abnormal volume within the window of opportunity for the DWT schemes and how the volume changes after changes in the general DWT rate, changes in the standard settlement cycle, and after the implementation of legislative measures directly aimed at limiting the DWT schemes. We format the data as panel data where each dividend distribution is an individual entity and a 61-day window as the time dimension. Since we are dealing with multiple countries, the volume will be standardised to ensure equal contribution to the coefficients, i.e. on a comparable scale across borders.

We contribute to the existing research by checking whether the DWT rate in the different countries affects the investor's decision to perform DWT schemes. We also look for indications that DWT schemes are present in countries that have not been mentioned much in previous literature by testing if changes in abnormal volume happen according to the theory about the DWT schemes after a change in the standard settlement cycle. Lastly, we will explain what measures the different regulatory authorities have implemented to combat DWT schemes' presence and whether these measures have had the desired effect.

Figure 1.1 gives an overview of the European countries treated in this thesis. Figure A shows the countries mentioned in the Cum-Ex files, while Figure B shows countries that have changed the general DWT between 2004 and 2020. Figure C shows the countries that have transitioned from a T+3 to a T+2 settlement cycle. Finally, Figure D shows the countries we have included in our data for this thesis.

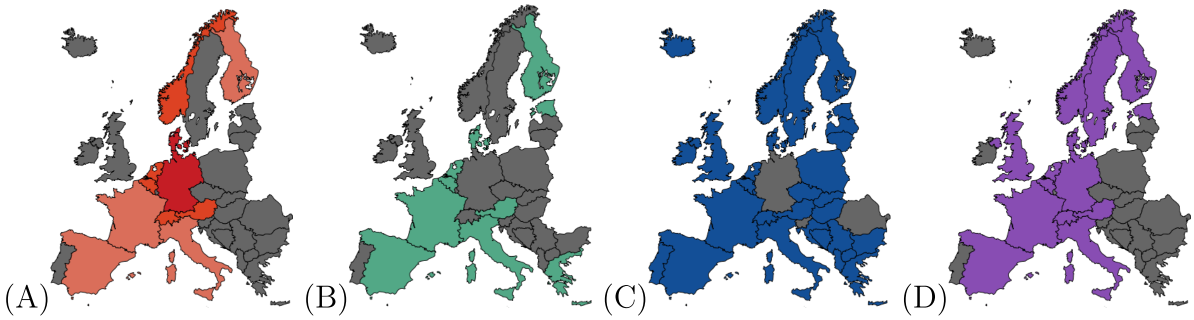

Figure 1.1: *(A) Countries mentioned in the Cum-Ex Files, (B) Countries with changes in the general DWT rate, (C) Countries with a change from T+3 to T+2 settlement cycle, and (D) Countries covered in this thesis.*

2 Theory

This section covers relevant literature on investor behaviour around the ex-date, both related to DWT schemes and other reasons for excess volume. We also cover the applications of the DWT, how dividend distributions relate to the settlement cycle, and the theory related to the different DWT schemes. Further, we discuss how changes in the general DWT rate fits with the existing theory on investors behaviour on tax changes and tax evasion.

2.1 Literature review

The DWT schemes we will cover in this thesis is a new phenomenon to the public. Not much research exists yet on the topic. The most relevant article that exist on the subject is by Büettner et al. (2020), which we will discuss further. However, as the full scope of the DWT schemes is being uncovered across impacted markets, the focus is gradually increasing. For example, Zoutman (2019) is leading the project; TAXLOOP to get a better understanding of the DWT schemes across Europe. The project aims to: find out which countries have been affected by the DWT schemes; quantify how much tax revenue has been lost; identify the critical weaknesses in the tax code exploited by investors; and redesign the DWT framework in Europe.

This section will first discuss trading around the ex-date in the existing literature to obtain an overview of reasons for abnormalities around the ex-date unrelated to DWT schemes. We then discuss the paper by Büettner et al. (2020) on cum-ex trading in Germany. Finally, we will cover the relevant theory regarding dividend withholding taxes, settlement cycles and how DWT schemes operate.

2.1.1 Dividend Irrelevance Hypothesis

According to Modigliani and Miller (1959), in a world with perfect capital markets, the firm payout policy is irrelevant both for the firm and its investors. The intuition behind this irrelevance is that in perfect capital markets where investors are unhappy with the firm's payout policy, they restructure the position to replicate their desired cash flow. We present this theory for a two-period world in Equation 2.1 where P_{cum} is the price of the asset before the dividend is paid to the investor and P_{ex} is the price after the dividend is paid and D is the value of the dividend paid out. The cum-date and ex-date is separated by only one day. Therefore the cost of capital is negligible, and the equation can be simplified as:

$$P_{Ex} = P_{Cum} - D \tag{2.1}$$

The implication is that once the dividend is paid, the stock price should drop equal to the dividend payment. The investor has two strategies: selling the stock cum dividend and repurchasing the stock at ex-dividend or holding their position. From Modigliani and Miller's proposition II (MM II), it follows that the investors would be indifferent between dividend payments or capital gains. Hence there should not be any excess trade around this period. However, the assumptions behind this relationship between stock prices and dividends do not hold in reality as perfect capital markets do not exist, and abnormality around ex-dividend day has remained one of the most controversial issues in corporate finance theory (Berk and DeMarzo, 2014).

2.1.2 Abnormal Trading Around Ex-Date

Dasilas (2009) divides explanations of excess trade around ex-day into three categories:

- **The tax-effect hypothesis:** Explains abnormal trade around ex-day as an effect of preferential tax treatment on capital gains over dividends (or vice-versa). Meaning that $\tau_C \neq \tau_D$.
- **The short-term trading hypothesis:** Explains abnormal trade around ex-day from the perspective that the existence of transaction costs results in stock prices not dropping by the exact amount of the dividend, commonly known as dividend stripping.
- **Micro-structure impediments:** This is a relatively new theory that explains abnormal trade around ex-day as, for example, due to tick size and bid-ask spread causing abnormality in the prices around the ex-date.

Miller and Modigliani (1961) also make the case that even when investors face different tax rates, the dividend irrelevance hypothesis still holds. The argument known as the *clientele effect hypothesis* argues that when investors are subject to different tax rates, investors will invest in securities with payout policies that match their preferences. This further implies that if investors have available securities with their preferred payout policies that also match their other preferences, the irrelevance proposition (MMII) still holds.

Elton and Gruber (1970) developed a framework to test the clientele effect hypothesis of Miller and Modigliani (1961) by looking at the effect of taxes on the marginal investor. They developed a model where investors are subject to one tax rate on ordinary income or dividends, τ_D, and a different tax rate on capital gains, τ_C. P_0 was the price when the investor bought the stock. If the investor sells his stocks right before the dividend is paid, the profit would be:

$$\pi_1 = P_{Cum} - \tau_C(P_{Cum} - P_0) \tag{2.2}$$

Where P_0 is the price when the investor purchased the stock. If the investor sells his stock right after the dividend is paid, the profit would be:

$$\pi_2 = P_{Ex} - \tau_C(P_{Ex} - P_0) + D(1 - \tau_D) \tag{2.3}$$

If we set $\pi_1 = \pi_2$ we can find an expression for the equilibrium where the investor would be indifferent between the two strategies. The condition is given by:

$$PDR = \frac{P_{Cum} - P_{Ex}}{D} = \frac{1 - \tau_D}{1 - \tau_C} \tag{2.4}$$

With the existence of different tax rates, Equation 2.4 can be viewed as the expected price drop ratio (PDR), still ignoring transaction costs and assuming full information. As we can see from Equation 2.4 if $\tau_D = \tau_C$, then PDR is equal to 1, in line with Modigliani and Miller's Dividend Irrelevance hypothesis. Furthermore, if $\tau_D > \tau_C$, the price will drop more than the dividend and if $\tau_D < \tau_C$, the price will drop less than the dividend payment. Looking at dividend distributions at the NYSE exchange in 1966 and 1967, Elton and Gruber (1970) find that prices ex-day fell consistently lower than the dividend. Further, they divided the dividend distributions into different groups based on the dividend yield[1] and calculated the mean PDR for each group. They found that the PDR increased with dividend yield, which suggests the existence of dividend clientele classes as investors in lower tax brackets prefer higher dividend yields and investors in higher tax brackets prefer

[1] Dividend Yield=$\frac{D}{P}$

lower dividend yields. Several studies have built on Elton and Gruber (1970), testing the tax-effect hypothesis and the existence of tax clienteles in different markets focusing, for example, on transaction costs, changes in the tax code, and other institutional changes (Lakonishok and Vermaelen, 1986; Michaely and Murgia, 1995; Michaely and Vila, 1995).

Kalay (1982) disagrees with the tax-effect hypothesis and introduces an alternative explanation known as the *short-term trading hypothesis*. Kalay (1982) argue that short-term trading rather than clientele effects cause the difference between PDR and the expected price drop in the stock. The article argues that an investor subject to only one tax rate ($\tau_C = \tau_D = \tau$) can make a profit by buying the stock cum dividend and selling it ex-dividend. The trade is profitable as long as the stock price drops less than the dividend, the dividends receivables, and the tax savings from capital loss are greater than the transaction costs. Alternatively, if the stock drops more than the dividend, the investor could still make a profit by selling short at P_{Cum} and buying the stock at P_{Ex} to close the short position. Formally, the trade will be profitable if:

$$(1-\tau)\Big(D-(P_{Cum}-P_{Ex})-A\Big)>0 \tag{2.5}$$

Where A[2] represents the transaction costs associated with the trade. Profit will only be realised as long as arbitrageurs do not operate to wipe it out.

Lakonishok and Vermaelen (1986) tested the hypothesis by Kalay (1982). They found that trading volumes increase significantly before and after ex-dividend days, with more abnormal volume for high-yield actively traded stocks. They also infer an abnormal price increase before ex-days and abnormal price decreases after the ex-day. Their analysis is from 1970 to 1980 NYSE stocks. In this period, there was a reform that introduced negotiable brokerage commissions, reducing the transaction costs. The study finds that the effects were more prominent after the reform, suggesting that abnormal trading increases with higher dividend yields and lower transaction costs, in line with the arguments put forward by Kalay (1982). Several studies have been conducted, looking at the short-term trading hypothesis in different markets and institutional settings. (Dasilas, 2009; Blau et al., 2009)

[2] This is a simplification of the original model.

2.1.3 Cum-Ex Trading in Germany

Büettner et al. (2020) is one of the most relevant empirical studies regarding DWT schemes. The article's main objective is to test if Germany has achieved the desired effects following the 2012 tax reform to limit cum-ex trades. They analysed market data for publicly traded German stocks from 2009 to 2015 on both non-taxable dividends (not subject to DWT) and taxable dividends suitable for cum-ex trades. They find a significant reduction in volume around the ex-date shortly after the 2012 reform. The effect on abnormal volume is also more significant for taxable stocks than non-taxable stocks.

They also build on the framework of Elton and Gruber (1970); Kalay (1982) to develop and test a collusion hypothesis: Stating that no arbitrage opportunity can be achieved without collusion between more than one institution or individual due to transaction costs and risk exposure. The collusion hypothesis is supported by findings of no effect on stock market prices after the increase in volume. Like Lakonishok and Vermaelen (1986), the article also checked for differences in volume for high dividend yield compared to low dividend yield companies and found more abnormal volume for high dividend yield companies. They partly infer this to short-term trading that cause the demand for the shares to increase shortly before the ex-date.

2.2 Dividend withholding taxes

Dividend withholding tax (DWT) is a tax levied on investors owning shares in domestic firms for dividend payments. Contrary to regular dividend or income taxation, the tax is collected on behalf of the tax authorities by the company, meaning the dividend paid out to the investor is usually already subtracted the DWT (Schreiber, 2013). Usually, the recipient of the dividends would be subject to income taxation on the dividends when they are declared in their country of residence, which results in double taxation. The dividends are first taxed by the company's country of origin (through the DWT) and then taxed again in the country where the investor resides. To solve double taxation, countries with aligned economic interests typically enter into Double Taxation Agreements (DTAs). The process of receiving this reduction varies between different jurisdictions (McGill, 2009). The DWT can usually be reduced due to an applicable tax treaty or tax-exemption rules that each country in our sample has with other jurisdictions. Often these reductions happen after the tax is paid through refunding procedures, which is where the DWT schemes are focused. In Europe it is important to note that under European law, investors must be treated the same, irrespective of their country of domicile. The implications is that European investors will face the same DWT rate and have the same rights for tax refunds as domestic investors (McGill, 2009). The investors that are looking to perform DWT schemes will often be operating from a low tax jurisdiction. The General DWT rate, which we use in this thesis, is usually the general DWT rate is levied on trades originating from these jurisdictions.

2.3 Settlement cycles

When securities are trading on an exchange, the share does not change ownership on the same day but later on the settlement date. In October 2014, European markets aligned to a T+2 settlement cycle, meaning that the settlement date occurs two days after the actual trade across European markets (European Central Bank, 2014). The T+2 standard has not always been the case. Some countries have previously been operating with a T+3 settlement cycle with settlement three days after the trade. There are several dates of importance regarding the settlement cycle and dividend distributions that can be seen in Figure 2.1. First, we have the *declaration-date*, which is when the company announces the intent to distribute a dividend to their investors. Then, we have the *record-date*, on which the company looks at its shareholder register to determine which shareholders are entitled to dividends. Lastly, we have the *payment-date* where the dividend gets transferred directly or indirectly to the investor. The day of most importance to an investor is the *ex-date*. Ex-date is the first day where the security is trading *without* dividend entitlement, which means the investor must have bought the share one day before the ex-date with entitlement to the dividends. As of early 2021, all European markets operate with a T+2 settlement cycle, which means the ex-date will be one day before the record date. The investor would have to buy the security two days before the date record date to be entitled to the dividend. This date is also known as the *cum-date*. When the dividends are paid in a T+3 settlement cycle, the ex-date is two days before the record date. Some countries have also previously been using another principle rather than the record-date principle where the ex-date is happening one day *after* the record-date (CNMV, 2016).

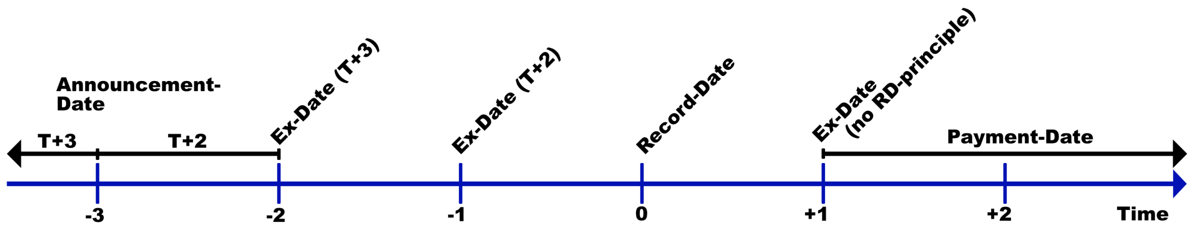

Figure 2.1: *Timeline highlighting the important dates for dividend distributions - Source: Own contribution*

On October 6th, 2014, European markets went through a settlement cycle migration from a mix of T+3 and T+2 to be standardised at T+2 (Clearstream, 2014). The effect of the transition is that the window of opportunity for selling a share with and delivering without dividend entitlement (cum-ex) is reduced by one day[3].

2.3.1 OTC trading

Over-the-counter (OTC) trading is when the security is not traded through an exchange, but instead through either a broker or directly with the counterpart (Murphy, 2020). One aspect that is interesting with OTC trading is that it does not always follow the standardised rules of the exchanges regarding the settlement cycle. The parties can deviate from the standard settlement cycle. This means that potential DWT schemes would not be picked up within the event window in our analysis. In addition, as OTC trades are not carried out through the official exchanges, it is also feasible that much of the collusion is happening through these venues, which would be a problem when using data from the main exchanges to analyse DWT- schemes. Büettner et al. (2020) claim that most investors want to stick to the standard settlement cycle to minimise the risk of exposure due to market fluctuations. However, intuitively, it would also make sense for these trades to move to OTC platforms due to higher regulatory awareness in recent years (ESMA, 2020).

2.4 DWT schemes

The mechanics of DWT schemes cannot be generalised, and an in-depth examination of the structure of each specific scheme would be required. We will therefore give three

[3]For all countries except Germany, which was already on a T+2 settlement cycle. And Spain that transitioned on September 29th, 2016.

examples of DWT schemes in the thesis. However, similar schemes may not follow the same principles as they adapt to local legislation and procedures.

2.4.1 Cum-Cum

Cum-cum seeks to exploit differences in effective tax rates for different types of investors. Cum-cum, as with cum-ex, involves trading around the ex-date, but it is a less aggressive scheme that is much easier to both understand and execute. The scheme involves both trading with (*cum*) and delivering a security with (*cum*) the entitlement to the dividend with another party that has a lower tax burden on the dividend than the original owner, consequently minimising the tax burden on the investor. The scheme has the potential of reducing or avoiding dividend withholding taxes, but unlike the cum-ex scheme, several tax reimbursements are not possible with cum-cum trading. The cum-cum scheme is often challenging to curtail due to legal violations as the legislative frameworks that could target cum-cum schemes are often formulated in a way that is difficult to enforce (ESMA, 2020).

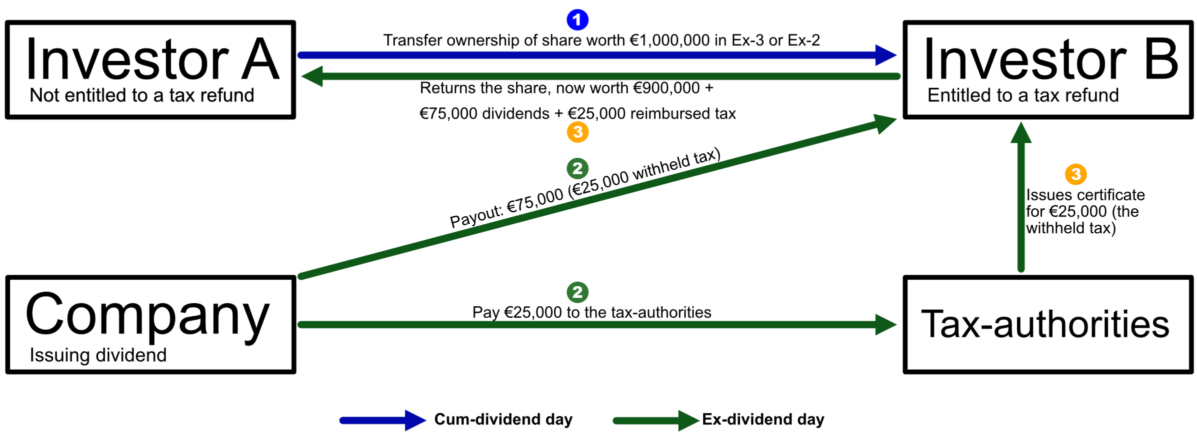

Figure 2.2: *Cum-Cum example - Source: Own contribution, inspired by Correctiv (2018)*

1. Investor A, who is in an unfavourable tax position compared to investor B, transfers the ownership of the shares, now worth €1,000,000.

2. The company now pays the dividend worth €75,000 to investor B and holds the DWT for the tax authorities.

3. The tax authorities now issue a tax certificate equal the DWT worth €25,000, and Investor B transfers back the shares, now worth €900,000 with the dividend worth €75,000. The reimbursed tax worth €25,000 is typically divided between the colluders.

Figure 2.2 shows an example of a cum-cum trade involving two investors. In general, cum-cum trades can be profitable as long as an imbalance in the DWT rate exists between the two investors. The imbalance means cum-cum trades can also be executed by using a domestic investor or an investor entitled to any level of reimbursement more favourable for one of the investors. Combined, investor A and investor B make a profit equal to $D(\tau^B_{DWT} - \tau^A_{DWT})$ compared with the passive alternative of non-collusion, ignoring transaction costs. From the tax authority's perspective (society), the loss associated with the cum-cum trade would equal the profit for the investor.

2.4.2 Cum-Ex

The cum-ex scheme seeks to exploit weaknesses in the administration of the DWT refunds. Our cum-ex example illustrates the scheme that was used in Germany. The term cum-ex is composed of the two Latin words *cum* and *ex*. Cum translates to "*with*", in this context securities trading *with* the entitlement to a dividend payment after the announcement date. Ex translates to "*out of*", meaning securities settle with*out* the entitlement to the dividends. Cum-ex is hence a strategy that, in short, involves trading a security first *with* the entitlement and then deliverance *without* the entitlement to the dividend payment. The scheme's characteristics are a high level of sophistication and complexity to give the impression that a series of genuine claims has taken place, which creates an opportunity to receive multiple refunds for a tax that has only been withheld by tax authorities once. The cum-ex scheme as defined in this section allows for several different approaches, some of which might not yet have been uncovered. The example in Figure 2.3 is based on the method used in the German market, uncovered in the Correctiv (2018); the Cum-Ex Files. Another illustration of a similar multiple reclaims cum-ex scheme that was also uncovered in Germany, can be seen in Appendix A2.1.

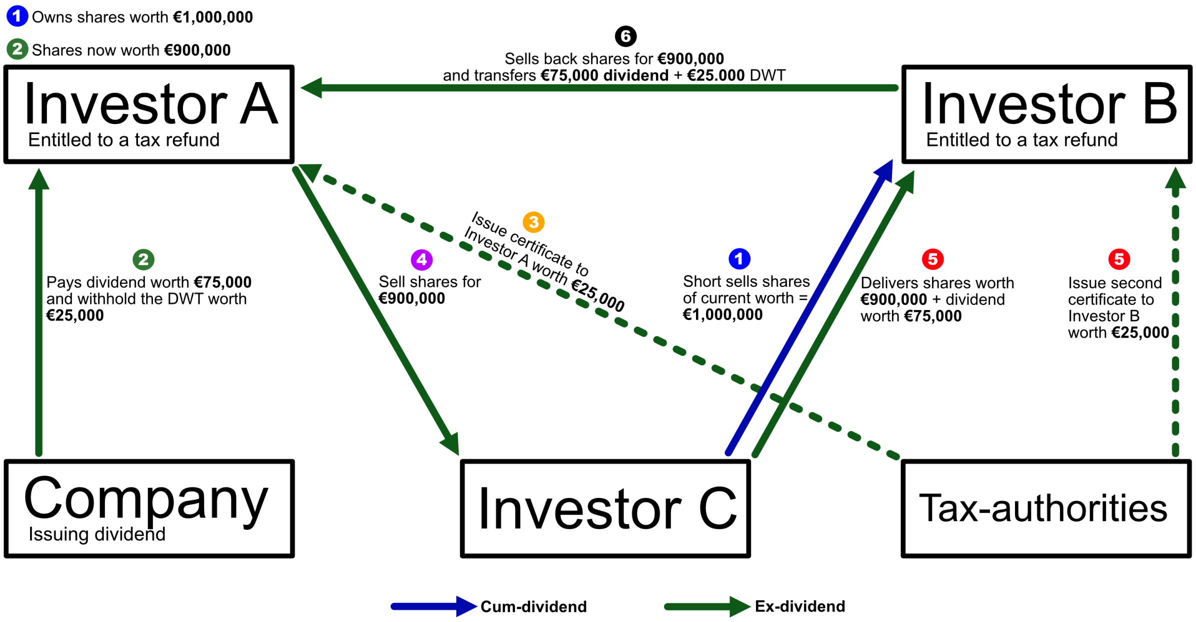

Figure 2.3: *Cum-Ex Example. Source: Own contribution, inspired by Correctiv (2018)*

In Figure 2.3 we describe the steps taken in the cum-ex scheme illustrated in (Correctiv, 2018).

1. One or two days before ex-date, investor A[4] owns the shares worth €1,000,000. At the same time, investor C sells shares to investor B that he does not own yet, but agrees to deliver at a later time. This happen cum-dividend.

2. The company then pays out the dividend worth €75,000 to the entitled investor A, but withholds the dividend tax worth €25,000. The value of the shares is now €900,000 as a result of the dividend payment.

3. The authorities now issue a tax certificate to investor A for the dividend withheld by the company. The withheld tax will be submitted to the tax authorities by the company.

4. Investor A now sells the shares he still owns to investor C which investor C then;

5. delivers to investor B to finish the claim for the short position and transfers the dividend worth €75.000 received from the company. At the same time, through the DWT reclaiming procedures, the tax authorities issue a *second* tax certificate worth €25,000 to investor B as he is also a registered owner of the shares.

[4]Often represented by a pension or investment funds, but can also be an individual investor

6. Finally, the shares are sold back to investor A from investor B for €900.000, and the dividend worth €75.000 is transferred to the tax authorities. The second tax certificate is being distributed among the colluding investors.

2.4.3 Cum-Fake

Cum-fake is a cum-ex variant that might be the most aggressive of the known DWT schemes. In this scheme, the investors receive a pre-released American Depository Receipt (ADR), which is a financial instrument offered to U.S. investors as a way to purchase shares in overseas companies that would not otherwise be available (Hayes, 2020). Through collusion between an investor and a broker, it is possible to appear as if the investor has received and paid tax on dividends related to the underlying share without any transactions of the share ever happening. The result is that the investor can receive tax reimbursements on taxes never paid. Many jurisdictions consider the scheme as a felony. In Figure 2.4, the reader can inspect an example of how a cum-fake scheme would work in practice; also included are the steps that need to be taken for the scheme to be legal and function as intended by the issuer of the ADR. As ADRs are a financial instrument with no actual ownership of the underlying equity, ADRs trading will not affect volume in the dataset we have gathered. We consider cum-fake as a method derived from the colluders adapting to legislative measures to combat other DWT schemes. Several cases of this scheme have uncovered in Denmark (Wigan, 2019). Using the German cum-ex scheme exactly as illustrated in Section 2.4.2 is not possible in Denmark due to different legal and institutional frameworks (Wigan, 2019).

The steps taken in Figure 2.4 are:

1. A depository bank located in the US issues a pre-release ADR to a broker located in the US.
2. The broker should now deposit stocks worth €1,000,000 in a European custodian bank but does not perform this action.
3. The US broker then lends the ADR to an EU located investor.
4. As a result of the stocks that should have been deposited in step 2, the company would have transferred €75,000 to the US broker and €25,000 to the tax authorities,

but the broker does not execute this action.

5. The US broker now transfers the net dividend worth €75,000 to the depository bank, which forwards it to the EU investor. This fabricated transaction leads the tax authorities to issue a certificate worth €25,000 to reimburse tax to the EU investor, which the tax authorities never received.

6. The EU investor returns the pre-released ADR to the US broker then returns it to the US depository bank.

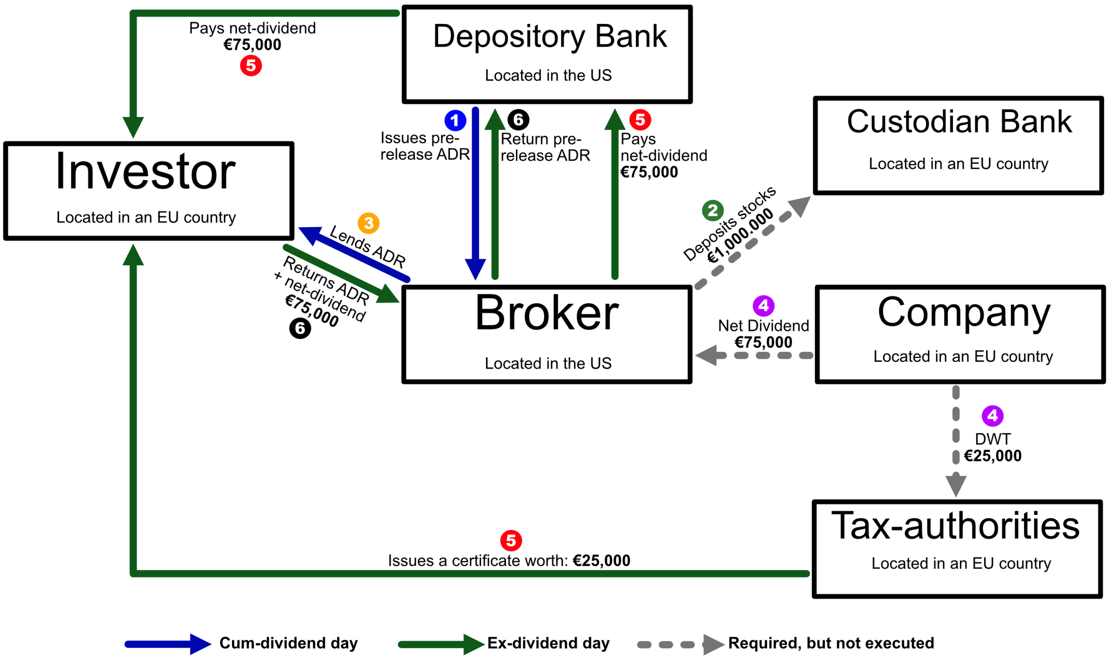

Figure 2.4: *Cum-Fake example - Source: Inspired by illustrations by Zoutman (2019)*

2.5 DWT Schemes in Relation to Settlement Cycles

When DWT schemes are possible depends on what settlement cycle the security is trading. In a T+2 system, a cum-cum transaction initiated by a spot transaction must happen at ex-3 or earlier for the trade to be traded and delivered, both with dividend entitlement. For cum-ex trades, the trade must happen either at ex-2 or ex-1 to be traded with and delivered without the dividend entitlement. In a T+3 settlement cycle, a cum-ex trade is also possible at ex-3. In the case of cum-cum trading in a T+3 settlement cycle, the spot transaction must happen at ex-4 or earlier to be both executed and delivered with dividend entitlement. For cum-cum schemes, the trader can also execute the trade at any time before this. However, as we assume investors would like to minimise transaction costs, we expect most cum-cum trading to happen as close to the ex-date as possible. Because of repurchase agreements, there will also be transactions executed on the ex-date or later. The repurchase agreement is the case of both cum-cum and cum-ex trades executed as spot transactions. Figure 2.5 and 2.6 illustrates the window of opportunity for cum-ex and cum-cum in a T+2 and T+3 settlement cycle, respectively. A typical day for both settlement cycles is on ex-2. On this day, the cum-ex schemes are possible both in a T+2 and T+3 settlement cycle.

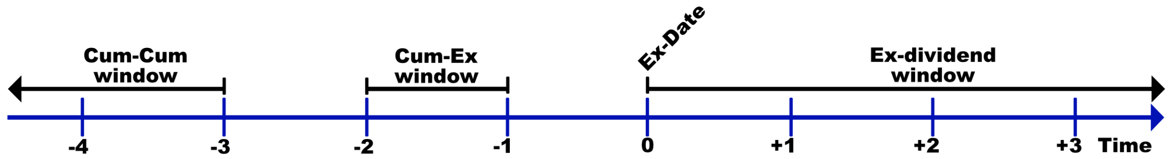

Figure 2.5: Timeline highlighting the window of opportunity for cum-ex and cum-cum schemes in a T+2 standard settlement cycle. Source: Own contribution

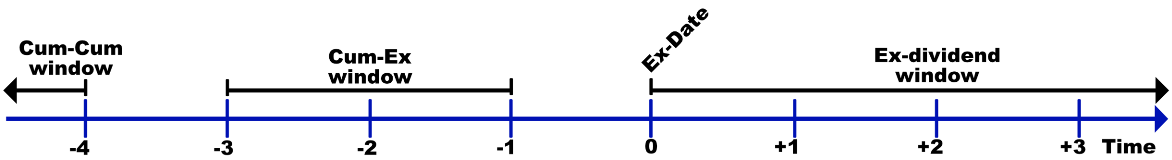

Figure 2.6: Timeline highlighting the window of opportunity for cum-ex and cum-cum schemes in a T+3 standard settlement cycle. Source: Own contribution

2.6 Legislative Measures to Combat DWT schemes

As mentioned in the introduction, the legality of the DWT schemes is difficult to determine, and even when the legality is determined, other problems arise. In many countries, there is ambiguity as to which institutions should be responsible for the treasuries funds lost due to DWT schemes. It is either a problem arising in the financial markets or a problem arising from taxation legislation. Both financial authorities and the tax authorities are involved. Often, the communication and inability to delegate responsibility is a factor that makes defining the legality and prosecuting the schemes difficult. In Denmark, the communication between the tax authorities and financial authorities have improved significantly after the scope of the DWT schemes became known, as authorities recognised the DWT schemes as a real threat to the integrity of the markets (ESMA, 2020). In Germany, the cum-cum scheme was until 2016 considered legal if prosecutors could not prove that the nature of the trade is anything but tax-related, which is difficult for any prosecuting authority to prove (Büettner et al., 2020; Podkul, 2016).

There have been several legislative measures designed to limit or outlaw DWT schemes that will be addressed in this paper, some implemented by the EU (European Banking Authority, 2020a), and some passed by the individual member states (ESMA, 2020). The individual countries' legislative systems still differ from each other, which is why the judicial status of DWT schemes is complex. The trades often involve colluders from different jurisdictions. In the period we are analysing, the countries that have amended their legislation aimed at limiting DWT schemes are Germany, Denmark, Austria, Belgium, France, Switzerland, and Norway. In addition, there have also been other attempts to limit DWT schemes by increased surveillance and monitoring of the market (ESMA, 2020). The relevant measures implemented in the respective countries will be described in further detail in the country-specific analysis in Section 3.4. The DWT schemes vary across borders, and the amendments may have been influenced by other jurisdictions that have already amended their legislation. However, adapted schemes that have adapted to those changes are possibly still used. The schemes used in Germany circulated for a long time before being uncovered to the public. After the legislative changes in Germany, colluders moved to the Danish market mainly using the cum-fake method (Wigan, 2019). Therefore, we argue that it is naïve not to believe that colluders can adapt to the legislative changes to adapt the schemes or move to another market.

2.7 Investor Behaviour on Tax Changes

This thesis wants to test if an increase in the general DWT rate will increase trading around ex-date. An important question is whether the strategies are considered illegal as tax evasion or tax avoidance, which is considered legal. One could also argue that DWT schemes like cum-ex and cum-fake are not examples of tax evasion but instead trading schemes aimed at defrauding treasuries. In the case of DWT schemes, this distinction is not clear in European markets. As highlighted in European Banking Authority (2020b) report on DWT schemes, the legality of both cum-ex and cum-cum trades varies between jurisdictions. The different legal status of the schemes, and differences in potential penalties, make it hard to place the trades into a specific theoretical framework.

Allingham and Sandmo (1972) formulated a much-cited theoretical framework to explain how much tax an agent evades. The model, formulated as a maximisation problem where the agent decides how much revenue to report, subject to potential fines, fraud detection probability, and tax rate. We should highlight that the model does not directly apply to DWT as investors do not report this tax themselves. The company distributing the dividends withhold the tax is on behalf of the tax authorities. However, we can draw some general ideas of the effect of tax increases from the model. The effect of an increase in taxation is ambiguous on the investor. First, a substitution effect implies that an increase in the tax rate encourages more tax evasion. However, due to a decline in income due to the increase in taxes, there is also an income effect. The income effect lowers the risk tolerance of the investor. Ultimately which of these two effects dominates will determine the effect of the tax increase on tax evasion. There is also the question of whether there is a penalty for involvement in the different schemes in our setting.

If the trades are legal, there is no penalty involved, or if the risk of getting caught is negligible, we would expect an increase in DWT schemes when the tax rate increases, all else equal. As legislative authorities have become more aware of the DWT schemes and amend or implement new laws to clarify or make the schemes illegal, to limit DWT schemes. The increased risks associated with the regulations makes the effect of tax changes more ambiguous on investors according to the theory by Allingham and Sandmo (1972).

As covered in the discussion in Section 2.4.1 and 2.4.2, cum-cum schemes require two investors, and cum-ex schemes require three or more. Executing these trades will thus require some transaction costs (e.g. the fee paid to the brokers for facilitating the schemes) to execute the schemes. Under these circumstances, we expect these schemes to become profitable for certain investors when the DWT rate increases, leading to a higher aggregated level of DWT schemes. Hence the tax saved has to be greater than the transaction cost. A raise in the general DWT rate would therefore make more DWT schemes profitable.

We also find it likely that the motivation behind cum-ex trades and cum-cum trades might differ. Cum-ex aims to receive multiple refunds due to loopholes in governance, while cum-cum trades aim to lower the tax burden on dividends. Intuitively, we find it likely that cum-cum trades can be responsive to changes in DWT rates.

3 Data

For the analysis we used financial data gathered from the Standard & Poors Compustat - Capital IQ database from 2004 to 2020 for 14 countries, each country with its own purpose for the analysis. The reason for such a large sample is that we want to include countries where the general DWT has changed within the sample. In most countries this do not happen very often, so to use a narrow time window we would only be left with few changes within countries. We have also included countries of interest without a change in DWT within the sample, which can be utilised in country-pooled analyses.

3.1 Descriptive Statistics and Data Cleaning

The list of countries (and the corresponding ISO code for that country) are: Austria (AUT), Belgium (BEL), Switzerland (CHE), Germany (DEU), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), Great Britain (GBR), Italy (ITA), Netherlands (NLD), Norway (NOR), Sweden (SWE). The total sum of observations in the raw data is 30,759,031. In Section 3.1.1 we will describe what cleaning steps we have performed in which, after cleaning and extracting the data we can utilise in our analysis, we are left with 1,176,019 observations containing information about 19,279 dividend distributions. Further descriptive statistics for each country is found in Table 3.1.

Country	AUT	BEL	CHE	DEU	DNK	ESP	EST	FIN	FRA	GBR	ITA	NLD	NOR	SWE	SUM
N	561732	854593	1542149	4630514	942397	1198325	84411	860950	4071818	9371882	1756910	1117806	1028737	2736807	30759031
n	39223	80298	82899	87840	56852	116815	8662	82655	96502	199226	84546	76799	61915	101809	1176019
Dividends	643	1316	1359	1440	932	1915	142	1355	1582	3266	1386	1259	1015	1669	19279

Table 3.1: *Descriptive statistics for all the countries listed by their respective ISO-code*

3.1.1 Data Cleaning

We are most interested in what happens in proximity to the ex-date for each dividend distribution as this is where most trading related to DWT schemes occur. Furthermore, we need data for a wider time frame to distinguish between our event window and where the volume should be unaffected by DWT schemes.

In order to measure excess trade in the event window, we limit the time window from 30 days before to 30 days after the ex-date for each distribution[5]. Special dividends where the $t \in [-30, 30]$ overlap another distribution for the same company have been removed to ensure the same observations are not included more than once. If we used a wider window, more distributions would be removed due to overlapping time windows.

We then filter the data to only contain data for each company on the main exchange in the company's country of domicile. This is because the different exchanges often operate with different currencies, legislations, and settlement cycles. To synchronise every bit of country-level information would be too comprehensive to fit within the scope of this thesis. However, this may not be a problem if investors looking to collude in dividend arbitrage strategies put their effort where most of the volume is normally aggregated, as argued by Büettner et al. (2020).

We removed all companies that did not pay dividends in the time period. We rank the dividend-paying companies by liquidity, measured in total volume for the entire period. We keep only the 100 most liquid companies for each country, where at least 100 companies listed on the main exchange have paid dividends in the time period. These 100 companies are most likely the main target for the colluding investors. All countries have 100 dividend-paying companies in the time period except Austria and Estonia, so for these countries, we include all the companies that have paid dividends in the time period. Descriptive statistics regarding the number of companies in each country are available in Appendix A1.1.

We also removed distributions with missing volume data in the 61 day window, but this only consisted of a few distributions. Compustat only removes weekends in their database, and we identified most of the remaining missing values in the dataset as days where the exchange was closed (e.g. holidays) in the country where the company is listed, consequently with no trading or any other effect on the security. Only a few distributions contained unexplained missing volume, and these have been removed. Volume is listed in domestic currencies (thousands) and have been converted to Euros for the data to be comparable. To this purpose, we gathered daily currency data from The European Central Bank (2021) and converted foreign currencies to Euro according to the daily exchange rates.

[5] In similar research, several different windows being used ranging from $t \in [-10, 10]$ to $t \in [-60, 60]$. (Blau et al., 2009; Büettner et al., 2020)

Through the cleaning and preparations of the data, we have made the steps necessary to capture the window of opportunity for an investor looking to make profits from DWT schemes.

3.2 General DWT rates

We used yearly world corporate tax reports from EY (2004-2020) to identify changes in DWT rates. These 16 reports contain a large quantity of information regarding the tax legislation in countries worldwide. Some of the information that we deem to be relevant are accounted for and described for each country in Section 3.4. Each country has a lot of individual special agreements for different types of investors and double tax treaties. To account and control for every different deviation from the general DWT would be comprehensive. We consider the general DWT to be the potential gain for most investors in a DWT schemes, as we discussed in Section 2.2. The general DWT-rate for each country can be found in Table 3.2.

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
AUT	25	25	25	25	25	25	25	25	25	25	25	25	27.5	27.5	27.5	27.5	27.5
BEL	25	25	25	25	25	25	25	25	25	25	25	25	27	30	30	30	30
CHE	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DEN	28	28	28	28	28	28	28	28	28	27	27	27	27	27	27	27	27
DEU	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
ESP	15	15	15	15	18	18	19	19	21	21	21	20	19	19	19	19	19
EST	26	24	23	22	22	21	0	0	0	0	0	0	0	0	7	7	7
FIN	29	28	28	28	28	28	28	28	24.5	24.5	20	20	20	20	20	20	30
FRA	25	25	25	25	25	25	25	25	30	30	30	30	30	30	30	30	30
GBR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ITA	27	27	27	27	27	27	27	27	20	20	20	26	26	26	26	26	26
NLD	25	25	25	15	15	15	15	15	15	15	15	15	15	15	15	15	15
NOR	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
SWE	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Table 3.2: *Generalt DWT rates in percentage for sampled countries by ISO-code. Source: EY, 2020*

3.3 Ex-date

As we explained in Section 2.3, the ex-date is the most important date when doing a volume analysis within the settlement cycle since this is the first day the stock is trading without dividend entitlement. The data we gathered only provided us with the record date of the dividend distributions and according to the different settlement cycles described in Section 2.3. We have assigned the ex-date according to the respective settlement principle for each dividend distribution such that the ex-date is equal to t=0 for all distributions.

3.4 Descriptive statistics for individual countries

In this section, we will print the standardised volume, $S_{i,t} = (V_{i,t} - \bar{V}_i)/\sigma_i$ for each t $\in$ [-30,30] distribution around dividend payment, averaged at a country level. By standardising, we get the observations on the same scale regardless of the nominal volume in the different countries and obtain a measure for excess volume comparable across distributions. This is the same method Blau et al. (2009) use to get a comparable measurement of excess volume. A further explanation and the benefits of using standardised volume will be explained in Section 4.1. The observations in the volume plots are the average standard deviation (s.d.) from the mean volume for each 61 day period. The y-axis displays the trading volume, standardised at the distribution level and averaged at the country level, i.e. we achieve the average standard deviation from the mean volume for all distributions. The x-axis displays the number of days from, and with t=0 being the ex-date. Ex-3 and ex+3 have been marked with a dashed line to illustrate the window we expect to find excess trade due to the different DWT schemes. All countries in our sample have had both a T+2 and T+3 standard settlement cycle in some parts of the sample, except for Germany, which has only ever operated with a T+2 settlement cycle. For countries with changes in the general DWT, we have also included plots to illustrate these changes. However, in countries with several changes within the period, we have not produced comparison plots for each change since they would have little illustrative value.

3.4.1 All countries

When aggregating the average standardised volume across all the countries, we see a clear peak within the event window. In Figure 3.1 all the countries have been included in the graphics. The United Kingdom has had, in the entire time period we are analysing, no DWT imposed on the investors. Therefore, any excess trade around ex-day can not be explained by DWT schemes, as they are not possible to execute in the UK. In Germany, we know that both cum-ex and cum-cum have been a problem for the authorities, which should appear as abnormal volume around the ex-date.

In Figure 3.2 we removed the United Kingdom from the sample to reveal how the abnormal trading significantly increases around the ex-date for countries where DWT schemes can be possible. We will go through each country in the sample, explain when legislative steps taken to limit DWT schemes and provide descriptive presentations on the effect changes in general DWT has on the abnormal volume.

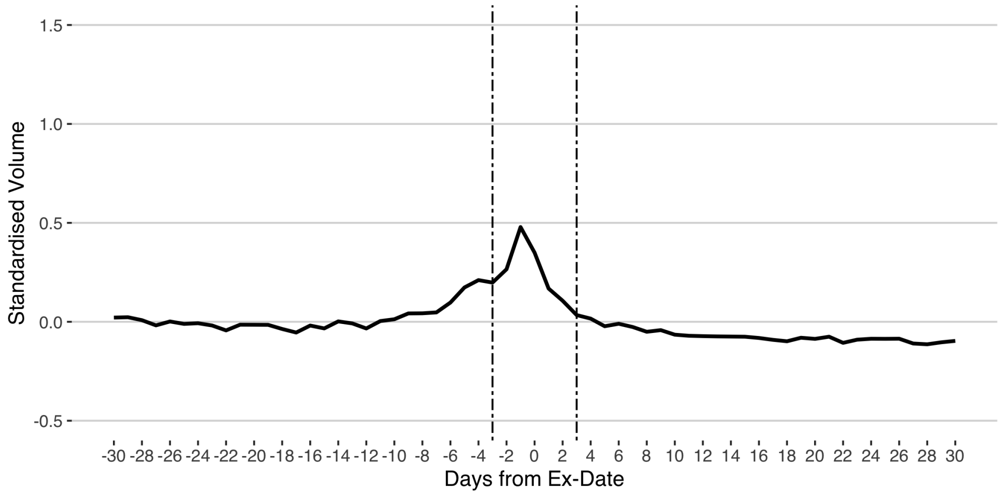

Figure 3.1: *Standardised volume for all countries*

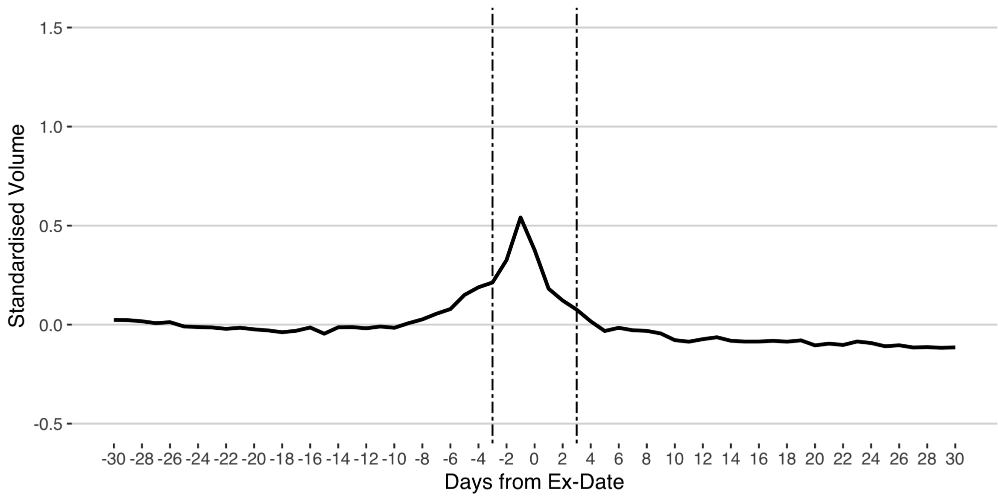

Figure 3.2: *Standardised volume for all countries except Great Britain.*

Figure 3.3 illustrates the difference in T+3 and T+2 settlement cycles. The plot indicates a decrease in ex-3 and an increase in ex-1 for distributions on a T+2 settlement cycle. The plot includes all countries except for the UK from the entire period (2004-2020). We have also included comparison plots of the transition from T+3 to T+2 settlement cycle and for legislative changes to limit DWT schemes for each relevant country. These plots can be seen in Appendix A3 and A4.

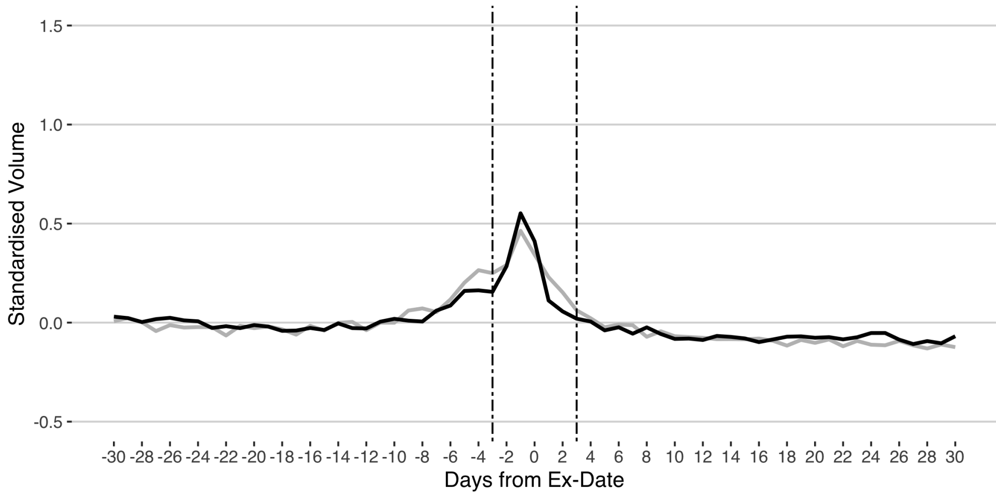

Figure 3.3: *All volume before and after the transitions from T+3 (grey line) to T+2 (black line).*

3.4.2 Germany

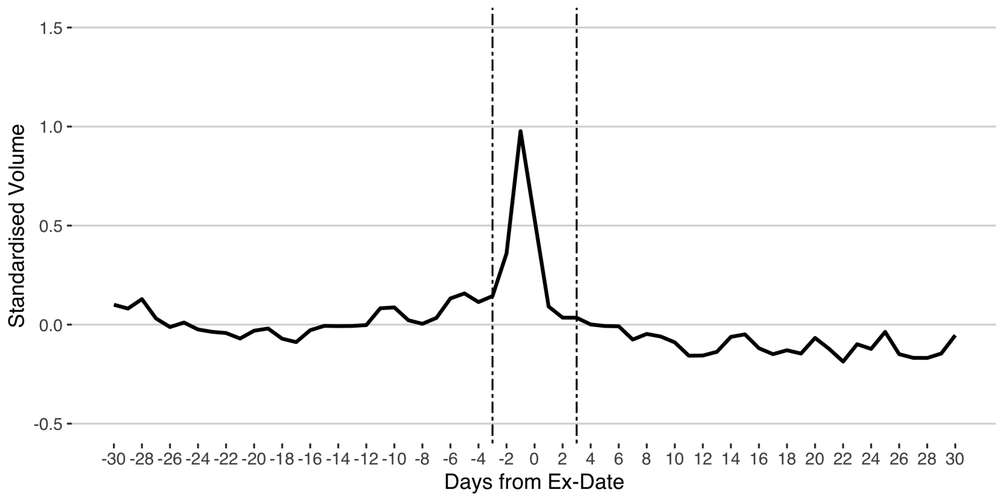

Figure 3.4: *Germany standardised volume*

Germany was the first country to uncover DWT schemes on a large scale. Of the estimated loss of a €55 billion to the European treasuries (Correctiv, 2018), an estimated €32 billion stems from DWT schemes in Germany (Wigan, 2019). Though similar variants of cum-cum have existed for a long time, an escalation of the more modern DWT schemes started in the early 2000's to the point where the schemes were illuminated and eventually addressed through prosecutions and legislative measures in 2012. Prosecutions that targeted the DWT scheme colluders started in Bonn, Germany, in 2019, with the first conviction followed by the presiding judge issuing a preliminary ruling that, for the first time, declared cum-ex a felony. The men in the Bonn case have been charged with "aggravated tax evasion" that cost the German treasury close to $500 million. Further prosecutions in Germany include 400 other suspects, unearthed in 56 different investigations (Segal, 2020).

There have been several investigations into DWT schemes in Germany Büettner et al. (2020); Wigan (2019); Correctiv (2018). As expected, the standardised volume in Figure 3.4 displays a significant peak within the cum-ex window in ex-1 of 0.943 standard deviations (s.d.) over the average trading volume. This indication of abnormal trading patterns around the dividend settlement can be linked partly to DWT schemes. We include the German data as we know DWT schemes have been a problem in the time period. Germany has not gone through any tax reforms that have affected the general DWT or a transition from T+3 to T+2. Germany is the only country in our sample that have always operated with a T+2 standard settlement cycle.

The tax legislation in Germany has been adapted twice directly aimed at limiting DWT schemes. In 2012, an implementation to limit cum-ex was admitted. The so-called debtor principle, which was the main weakness in the German administration of DWT refunds abused by the colluders, was replaced with the paying-agent principle. After the reform, issuance of tax certificates, and reception and transmission of the DWT was no longer carried out by different institutions, but rather have the same institution responsible for both withholding the tax and issuance of the DWT certificates (ESMA, 2020). The paying agent principle makes the true ownership of the securities more salient when issuing tax certificates. In 2016 an implementation to combat cum-cum was supplemented to the 2012 reform. The focus of the changes in 2016 is to make it harder to execute a cum-cum scheme in German markets. The change is related to how long an investor must hold the shares before and after the ex-date to be eligible for a tax refund (Junge and Kleutgens, 2016).

3.4.3 The United Kingdom

DWT schemes are only related to the avoidance or refunding of taxes and other forms of tax extraction. In theory, DWT schemes are not possible in the UK, as the UK impose no DWT on investors. There should not be any abnormal volume around the settlement cycle caused by the DWT schemes by this rationale. However, the volume could still be affected by other reasons for abnormal trading around the ex-date. In Figure 3.5 the standardised volume in the UK can be inspected. We observe an increase in the trading volume before the ex-date that is not as large as for those countries we know are affected by DWT schemes. Our hypothesis is that the increase in volume in the UK market is an indication of how much the volume should be affected by other reasons to transfer ownership as discussed in Section 2.

The volume in GBR seems to follow a trend-cycle of five days for the entire [-30,30] period around the ex-date, which the timing of the record date might explain. The record date in almost all the distributions happens on a Friday, which means we have an overweight of ex-dates happening on specific weekdays in our sample. For most of the other countries, the ex-dates are more evenly spread throughout the weekdays. An overview of the different countries' record dates can be seen in Appendix A1.2.

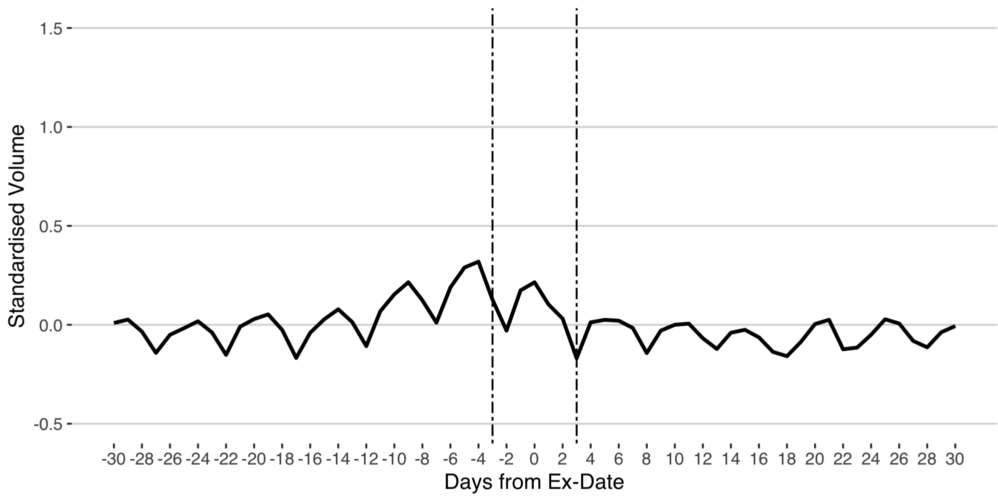

Figure 3.5: *Great Britain Standardised Volume*

3.4.4 Austria

Austrian authorities are, as of late 2020, investigating 15 firms and 30 people for involvement in DWT schemes within their jurisdiction (Milligan et al., 2020). Figure 3.6 in Austria seem to have a peak at ex-1 but only shows a slight increase in activity around ex-date with 0.2052 s.d. In 2016, the Austrian tax authorities increased the general DWT from 25% to 27.5%.

Figure 3.7 indicates a slight increase in abnormal volume after the tax increase to 27.5% (black line), still with a small peak in ex-1 and on the ex-date. The increase indicates trading around the ex-date after an increase in general DWT, which is according to our hypothesis regarding DWT effect on volume. We only see an incremental increase in the volume, which is can also be caused by other effects than the tax change.

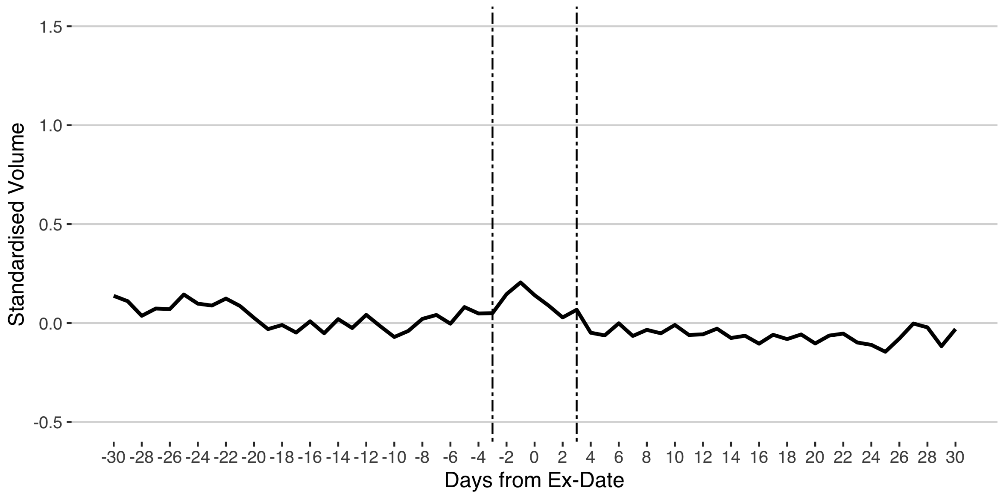

Figure 3.6: *Austria Standardised Volume*

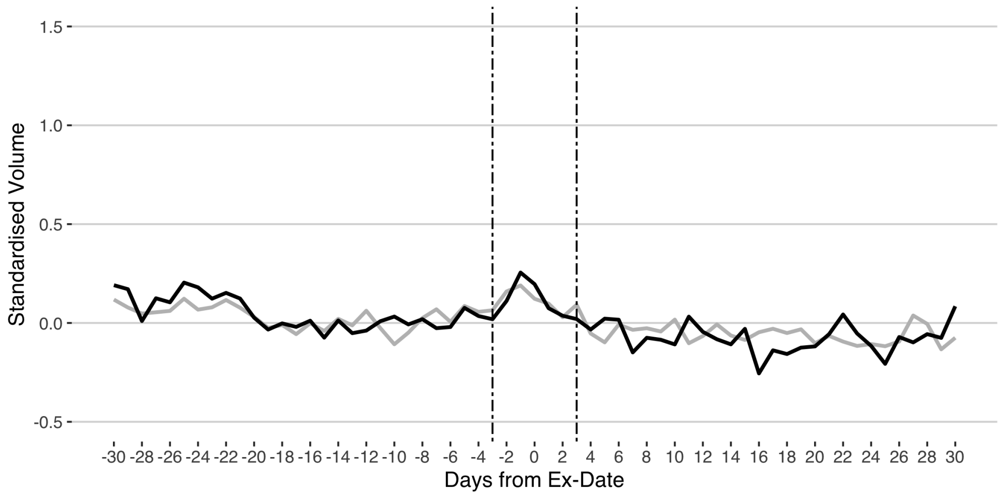

Figure 3.7: *Austria Standardised Volume comparison. Before tax change from 25% (grey) and after tax change to 27.5% (black)*

Austria made amendments to the Austrian tax law and the Austrian Code of Tax Procedure on January 1st, 2015. From this date, the applicants of tax reimbursements must submit their collective claims in a single application after the calendar year's expiration, and an intensifying of the obligation to provide evidence of entitlement to the DWT reclaim request (ESMA, 2020). As this measure happened in 2015, one year before an increase in the DWT rate, it should work in the opposite direction regarding the effect on volume. DWT schemes could now be more profitable due to the tax increase but more challenging to perform due to the new regulations.

3.4.5 Belgium

The Belgian authorities became aware of the DWT schemes after Germany and Denmark discovered the trades. According to a spokeswoman for the Belgian Finance Ministry, they were investigating a similar fraud after discovering illicit tax reclaims. Belgian tax authorities repaid €201 million before halting for larger reclaims, some as recent as 2017 (O'Donnell and Sims, 2018). In an ongoing investigation in Belgium, Sanjay Shah's Solo Capital are indicted for defrauding €22 million, of which €11 million were paid out as a result of unlawful DWT reimbursements on dividends paid by Belgian quoted companies (Milligan, 2021). Figure 3.8 indicates increased trading activity around the ex-date. The most active day in Belgium is at ex-1 with 0.2961 s.d, which could indicate cum-ex trading.

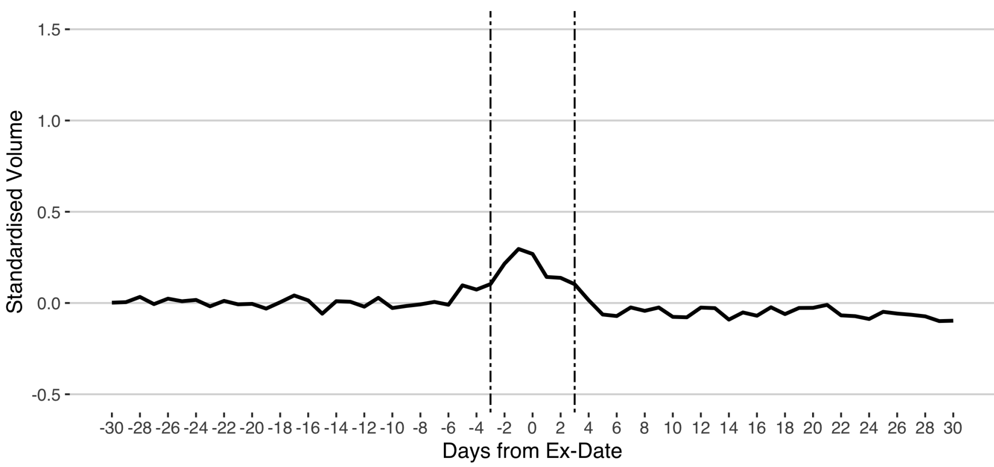

Figure 3.8: *Belgium Standardised Volume*

The change in the general DWT rate from 25% to 30%, shown as grey and black lines respectively in Figure 3.9 indicates that trading has increased after an increase in the general DWT rate. This is in line with our hypothesis. The general DWT rate in Belgium increased two times, first to 27% in 2016 and 30% in 2017. In Figure 3.9 the black line represents both increases in general DWT.

On January 22nd, 2019, Belgium implemented a new law directly aimed at limiting DWT schemes. Under the new law, all pension funds have to retain full ownership of their assets for an uninterrupted period of at least 60 days. Otherwise, the dividends received will be considered "artificial" regarding the tax legislation, and no reimbursement may be remitted. The DWT imposed on any dividend is to be used only to offset Belgian income tax and only if the beneficiary of the dividend has held the shares for 60 days. The requirements for entitlement to income deriving from a Belgian DWT have become stricter (ESMA, 2020).

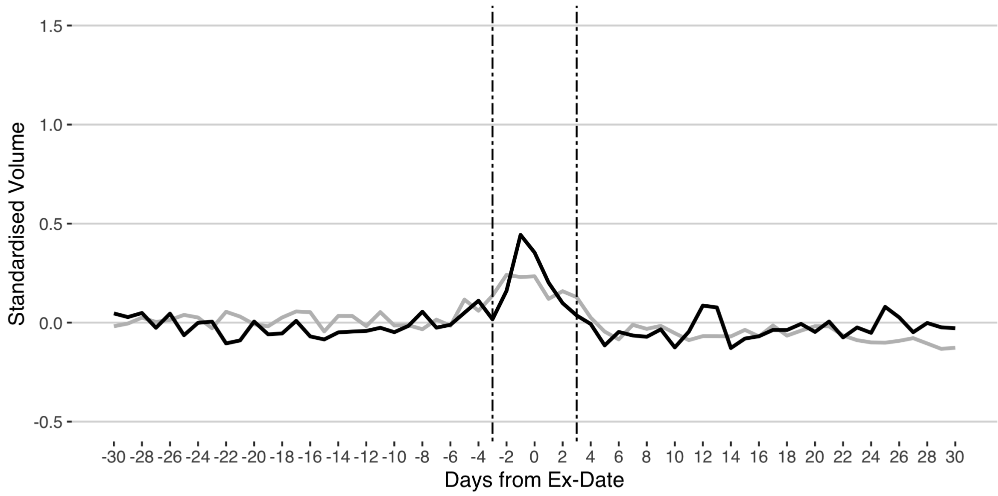

Figure 3.9: *Belgium Standardised Volume Comparison before tax change from 25% (grey) and after the change in the general DWT first to 27% in 2016 and to 30% in 2017 (black)*

3.4.6 Denmark

In Denmark, DWT schemes total an estimated 12.7 billion DKK tax revenue loss (ESMA, 2020). Reportedly, after the legislative changes in Germany in 2012, most colluders moved their activity to Denmark as the legal system had similar weaknesses to the pre-reform Germany. Cum-ex deals were executed primarily from 2012 to 2015 when Danish authorities were able to curtail the schemes. The cum-ex schemes discovered in Denmark were primarily structured as cum-fake schemes as described in Section 2.4.3, often where the entire ownership of the shares was completely fabricated (Wigan, 2019). The Danish authorities have embarked on aggressive prosecution for several other suspects (Schwartzkopff and Milligan, 2021).

The volume plot in Figure 3.10 in the Danish market also shows a marked peak around the ex-date, especially on the ex-date and ex-1, with respectively 0.2981 and 0.3819 standard deviations. Denmark is one of the countries where cum-ex were first reported to be a problem, so the observed abnormal volume within the cum-ex window is expected. Much of the DWT scheme activity in Denmark is focused on fabricated ownership, like cum-fake (Wigan, 2019), so this activity would not appear as volume in our data.

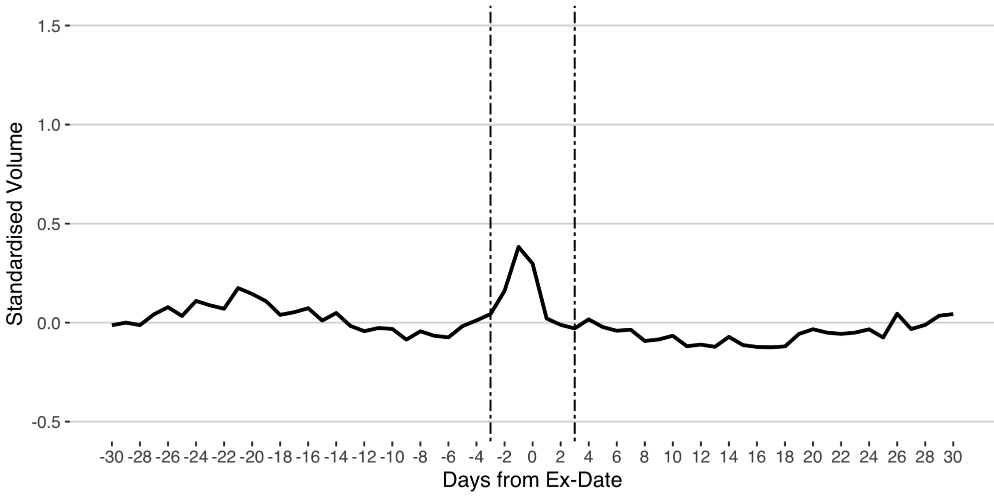

Figure 3.10: *Denmark Standardised Volume*

The comparison between before and after the incremental decrease in the general DWT from 28% to 27% in Figure 3.11 indicate that the abnormal trading has increased after a decrease in the general DWT rate. However, the change in the general DWT rate happened in 2013, after the loophole that allowed for cum-ex schemes closed in Germany. Therefore, the increase in Denmark's activity can be directly linked to the 2012 reform in Germany and not related to the DWT. The volume pattern is in contrast with our hypothesis. However, the tax change is relatively small.

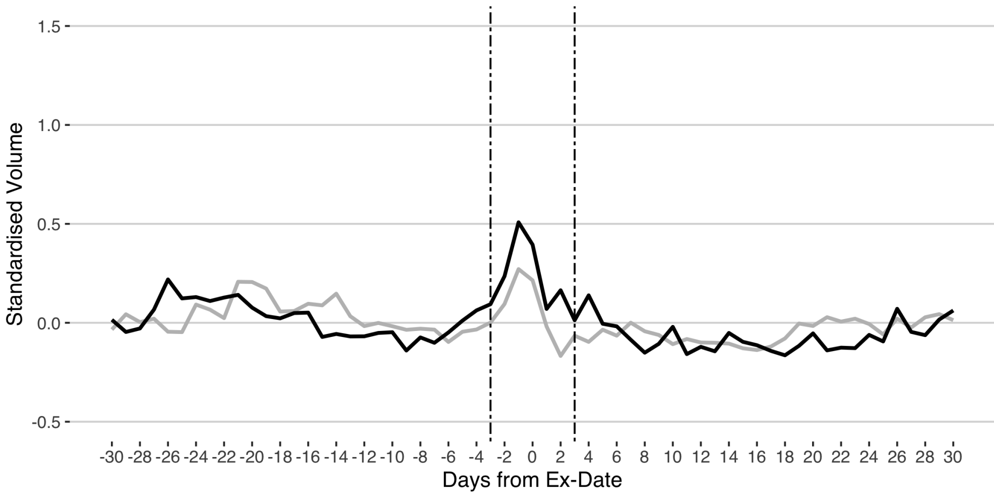

Figure 3.11: *Denmark Standardised Volume Comparison before decrease in the general DWT from 28% (grey) and after change to 27% (black)*

Denmark has, since the uncovering of DWT schemes in their markets, significantly increased the staff working in prevention (O'Donnell and Sims, 2018). Also, in contrast to some other countries, the communication between the financial authorities and the tax authorities works relatively well in Denmark, and with access to each other's data. In 2016, new regulatory measures was implemented, including five refund requirements that all have to be met to qualify for a tax refund from the Danish tax authorities (skat.dk, 2021). The Danish authorities uncovered the DWT schemes in Denmark without receiving information from the German authorities. The DWT schemes had been a known issue for several years, but confidentiality restrictions prohibited information sharing across the borders. If communication across borders had been more effective, the potential loss could have been reduced. Ineffective communication is one of the main reasons why DWT schemes have been possible at such a large scale for such a long time (Correctiv, 2018; ESMA, 2020).

3.4.7 France

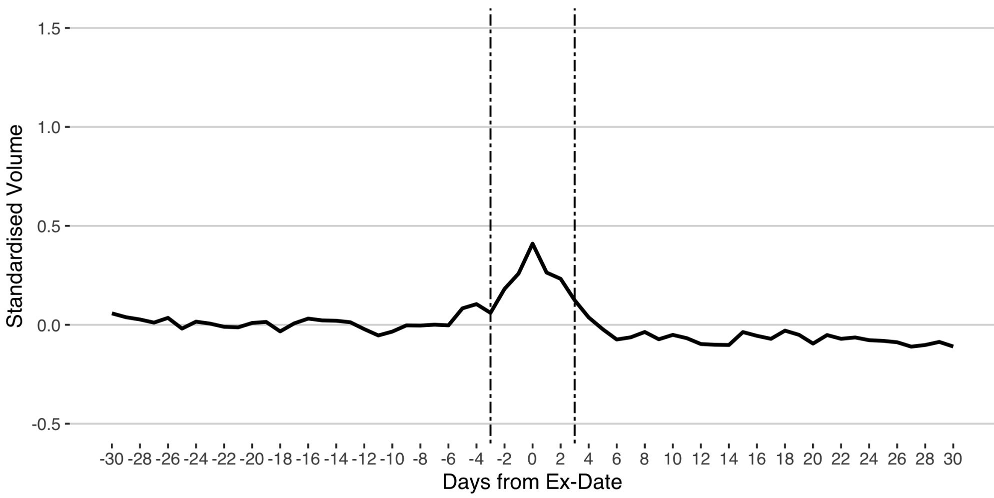

Figure 3.12: *France Standardised Volume*

In France, the authorities have been unwilling to make public the impact of the DWT schemes. So whether DWT schemes are a problem and the scope of the problem is not publicly known. The French tax authorities also highlighted that the French tax framework makes it impossible to perpetrate any multiple DWT reclaim scheme whose detection, investigation and sanction would, in any case, fall within the remit of the French tax authorities (ESMA, 2020). However, cum-cum schemes have been performed and were addressed in 2019 through legislative changes. The estimated loss to the French tax treasury is $17 billion (Segal, 2020). If these numbers are correct, France is the country hardest affected by the DWT schemes after Germany.

The French volume in Figure 3.12 looks similar to the other countries with abnormal volume within the event window. The highest observed volume is on the ex-date with 0.4101 s.d., rather than ex-1 or ex-2, which is the most prominent date for cum-ex trading. This means that the highest volume in France is on the first day of trading without dividend entitlement. We hypothesise that if multiple DWT schemes are not possible in France, as claimed by the authorities, the abnormal volume can be caused by the repurchase agreements in cum-cum schemes.

The comparison plot in Figure 3.13, shows similar, almost identical, patterns before and after the change in the general DWT rate. This indicates that not much has happened to the abnormal trading after the change in general DWT. The grey line represents a general DWT rate of 25%, while the black line is after the increase to 28%. They look relatively similar, but with a slight increase in abnormal trading in ex-2 and a small decrease in ex-3.

France amended the tax legislation on July 1st, 2019. The changes aimed at limiting DWT schemes is the requirement of proof of evidence from the beneficiary that the underlying transaction's main purpose is neither to avoid the application of a withholding tax nor to obtain a tax benefit (ESMA, 2020). Hence a similar change to that of Belgium, where the investors must prove that the financial transaction had other economic motives than the refund of tax.

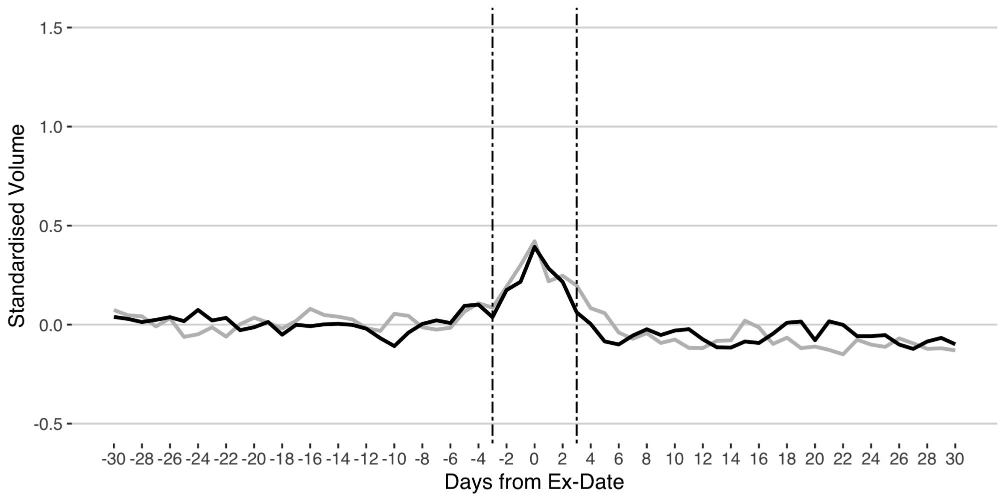

Figure 3.13: *France Standardised Volume Comparison before tax change from 25% (grey) and after tax change to 28% (black)*

3.4.8 The Netherlands

Inquiries forwarded to the Dutch authorities reveal that DWT schemes have been uncovered in the Dutch markets. However, estimates on the scope of the schemes are not disclosed by the authorities ESMA (2020). Several investors and banks based in the Netherlands have been subject to prosecution related to DWT schemes. However, we do not have information on which markets these schemes have operated in (Segal, 2020).

In the Netherlands, we observe a peak within the event window that indicates increased activity around the ex-date with the most excess volume at ex-2 with 0.6623 s.d. Except for the removal of DWT in Estonia, the Netherlands has the largest single reduction in their general DWT, which we observe in our data, changing from 25% to 15% in 2007. The sample size before the tax change is relatively small compared to the period after the change.

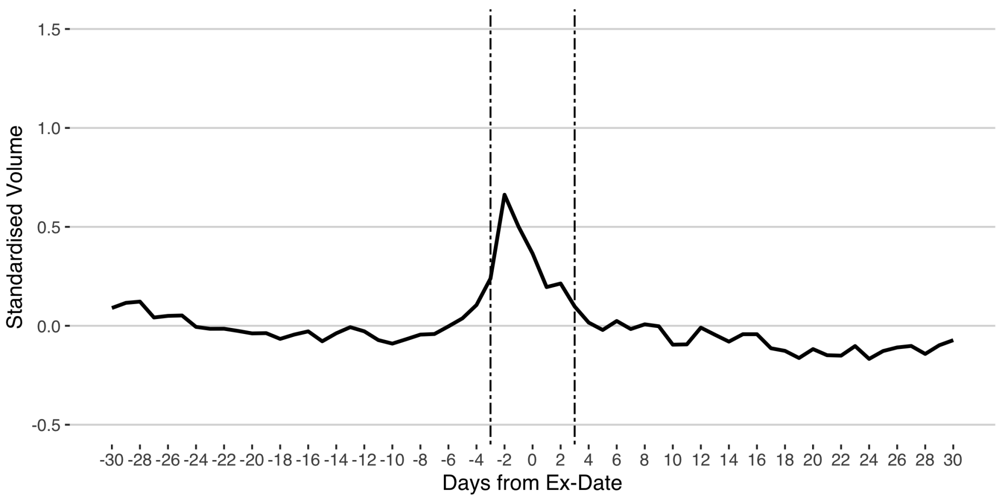

Figure 3.14: *Netherlands Standardised Volume*

Figure 3.15 show the volume when the DWT rate was at 25% (grey) and from 2007 when the general DWT rate was decreased to 15% (black). The patterns in the volume before the change is similar to the other countries we analyse. A big increase in volume is observed in ex+2, which can be explained by repurchase agreements.

The Dutch authorities have not implemented any legislative changes directly aimed at limiting DWT schemes. However, the Netherlands is one of the jurisdictions that have, through court decisions, characterised the cum-ex scheme as a felony. Cum-cum trades are still subject to ambiguity in the legal term, with a similar legal definition to Germany and France. Any trade needs to have another economic motive other than tax evasion to be considered legal.

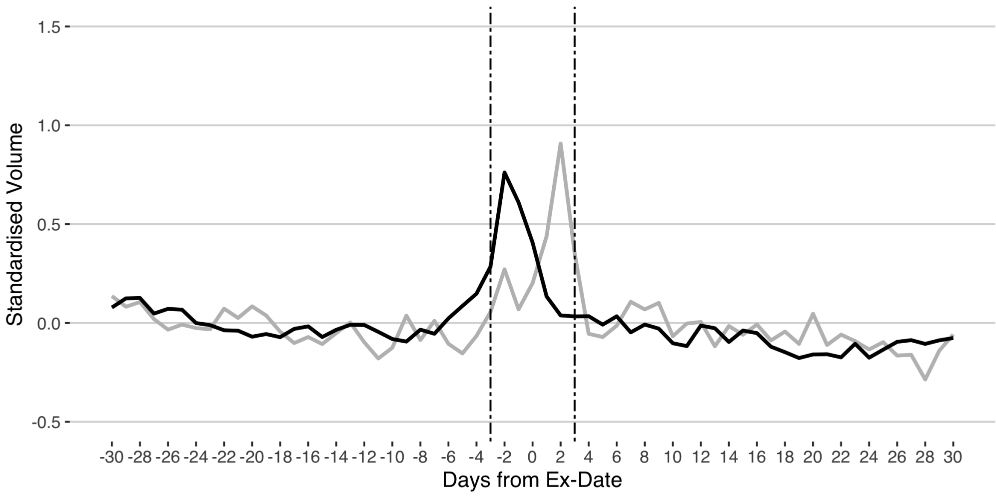

Figure 3.15: *Netherlands Standardised Volume comparison before DWT change from 25% (grey) and after DWT change to 15% in 2007 (black)*

3.4.9 Spain

Spain is the only country other than Germany and Norway in our analysis that issue tax credit certificates. Also, the settlement principle in Spain up until 2014 resembled the one in Germany, where the ex-date happens one day after the record date (CNMV, 2016). The questionnaires by ESMA (2020) have not uncovered any evidence of DWT schemes in Spain, but since the legislation has similar loopholes, the existence of DWT schemes cannot be disregarded. Not much other information is available on DWT schemes being carried out in the Spanish market, but several instigators of the schemes have been located in Spain. Particularly Santander Bank, which is under investigation for its involvement in facilitating DWT schemes (Crow et al., 2020).

In the 2004-2020 time period, Spain has changed the general DWT rate incrementally no less than five times. The volume for Spain in Figure 3.16 shows that there is a large spike in volume several days before the ex-date, in ex-4 with 0.6254 s.d. The volume appears to be abnormally high in the entire period around the ex-date. These patterns can be caused by DWT schemes that are not limited by a narrow window, like cum-ex schemes. Cum-cum trading have a wider window of opportunity, but if investors want to minimise transaction costs, we expect cum-cum trading as close to ex-date as possible.

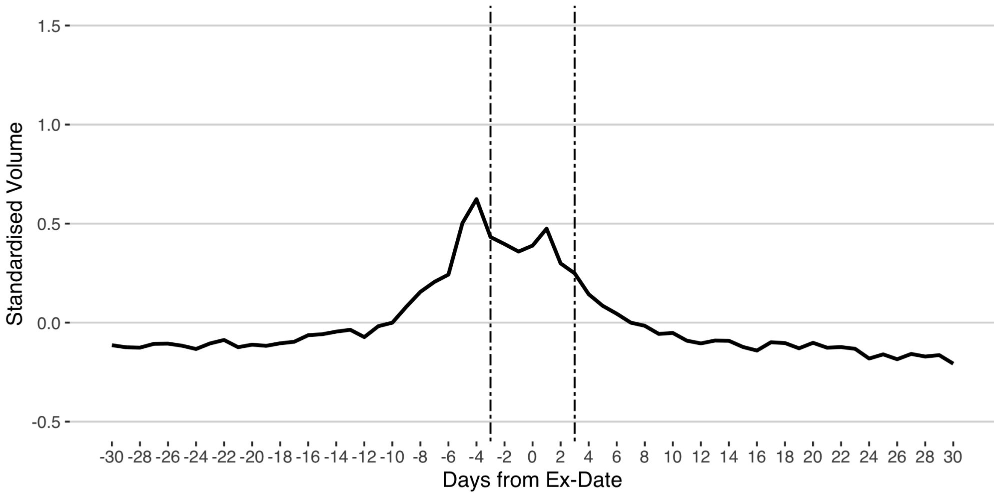

Figure 3.16: *Spain Standardised Volume*

3.4.10 Italy

Italian authorities have not uncovered DWT schemes that have lead to any prosecutions. On unrelated queries to regulators, schemes that resemble cum-cum schemes have been uncovered but on a smaller scale than in other countries (ESMA, 2020).

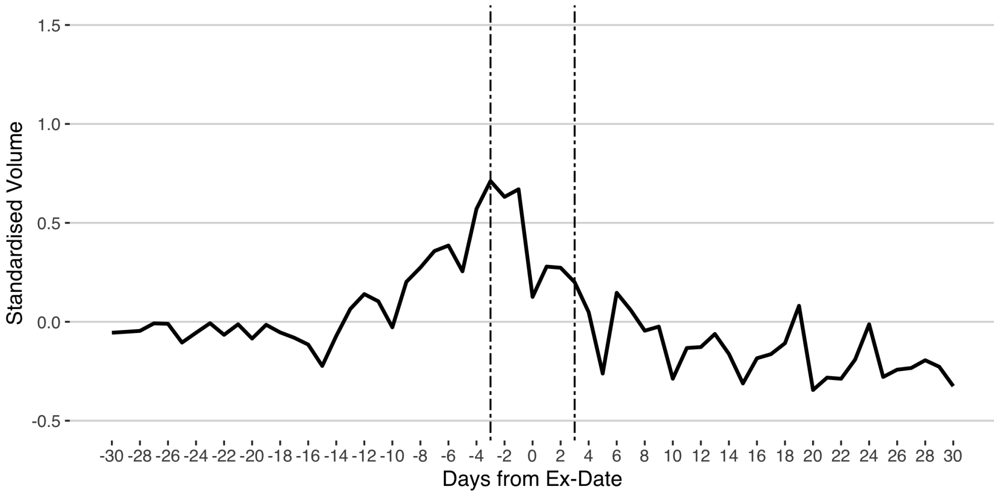

Figure 3.17: *Italy Standardised Volume*

In Italy, the general DWT rates have changed two times, in 2012 from 27% to 20%, and in 2015 back to 26%. Figure 3.17 of the Italian standardised volume show increasing activity both leading up to and after the ex-date. The day with most excess trading is ex-3 with 0.711 s.d. Figure 3.17 shows the standardised volume in Italy for the entire time period. The pattern in the volume shows a wider window of elevated trading levels. For now, we see this as support to the claim that multiple DWT refund schemes are not a problem in Italy, while cum-cum schemes have been observed. The wider window of opportunity in cum-cum schemes makes sense with a wider observed elevated volume. Similar to the UK, trend-cycle patterns are formed in Italy's volume for the same reason. In Italy, the record date almost always happens on a Wednesday or Tuesday, making the visible effect of weekday trading patterns present. The pattern is not as clear in Italy compared to the UK.

Figure 3.18 show the trading volume at the two general DWT rates 27% and 26% in grey and 20% in black. We observe a drop in the volume in ex-3 from 1.022 to 0.552 standard deviations. The volume in ex-2 is also lower but does not drop as much as in ex-3.

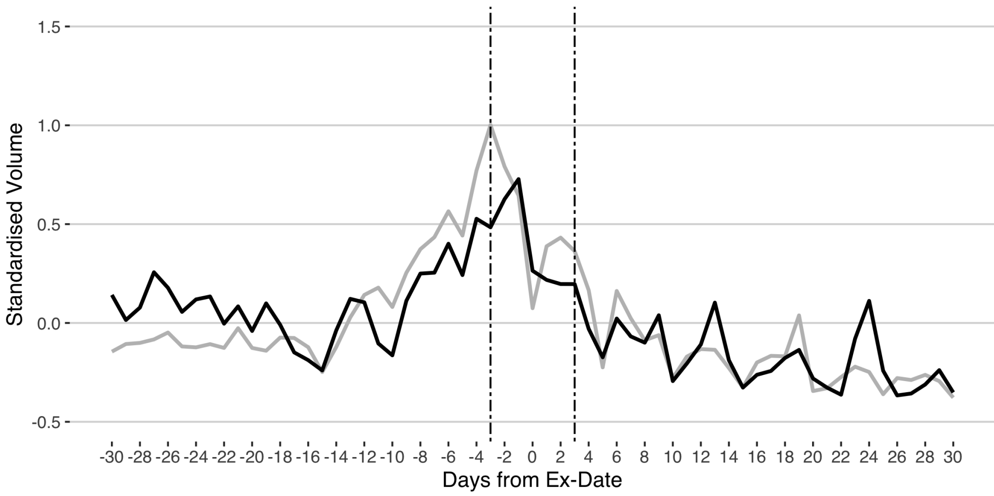

Figure 3.18: *Italy Standardised Volume comparison before DWT change from 27% (grey) and after DWT change to 20% in 2012 (black)*

Italy has not been mentioned much in previous reports regarding DWT schemes, and the legislation in Italy makes it relatively hard for colluders to target Italian markets. The presence of DWT agents with better control of who makes the deduction for the issuer and access to the identity of the beneficial owner combined with no-issuance of tax certificates makes it challenging to perform the multiple DWT reclaim schemes in Italy (ESMA, 2020).

3.4.11 Sweden

Sweden's treasury reportedly lost 14,3 billion SEK from 2006 to 2014 (NTB, 2018) allegedly only due to cum-cum schemes (SVT, 2018). DWT schemes were first suspected in Sweden after several names that appeared in the Danish investigation also occurred in recipients of refunds from the Swedish tax authorities.

In Figure 3.19, Sweden shows a significant increase in the abnormal volume within the cum-ex window, similar to the pattern observed in Germany. In ex-1, the Standardised volume is 1.064 s.d., almost equal to that of the German market. There is no existing substantial evidence that Sweden has been a target for multiple DWT reclaim schemes (ESMA, 2020).

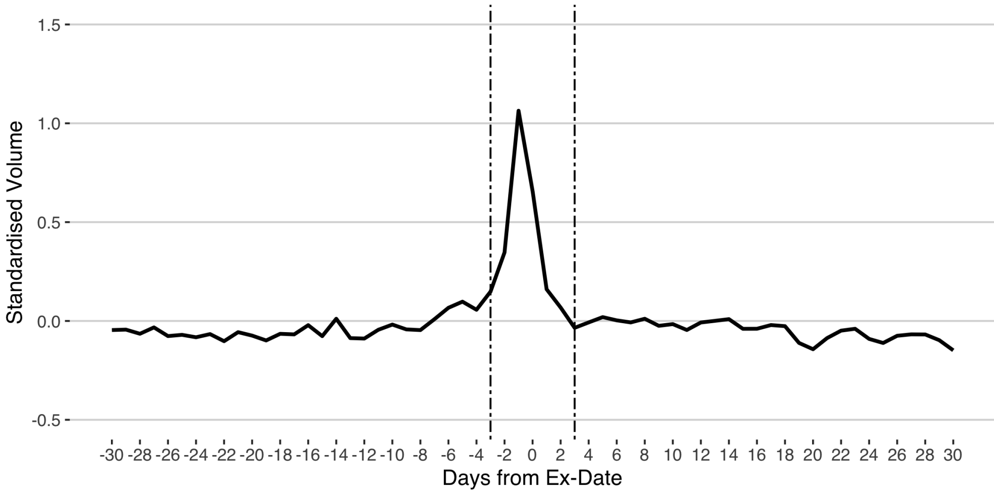

Figure 3.19: *Sweden Standardised Volume*

3.4.12 Norway

Norway was first informed of the DWT schemes possibly being performed in their markets by the Danish authorities. A single case of cum-ex was uncovered, totalling the known cost to Norwegian taxpayers to €50.000 in 2013. Only a few attempts at DWT schemes have since been reported, which reportedly have all been stopped by the authorities. Norway was able to stop attempts of fraudulent claims totalling $4.3 million after the first successful attempt in 2013 (O'Donnell and Sims, 2018; NTB, 2018).

Figure 3.20 indicates higher volumes around the ex-date in Norway but at a lower level than many other countries. The volume is 0.3435 and 0.3119 s.d. in ex-1 and ex-date, respectively, which is lower than in the hardest affected countries. The general DWT rate in Norway has been 25% for the entire time period.

Norway has implemented a legislative change regarding the refunding procedure for DWT, imposing more requirements of documentation on the investors for DWT refunds (BDO Norge, 2019). Norway has also increased surveillance. The Norwegian Tax Administration director, Hans Christian Holte, claimed that "After discovering these fraud attempts, we introduced much tighter checks before paying refunds". We expect the combination of a legislative change and more intensive supervision should lead to a decrease in abnormal volume.

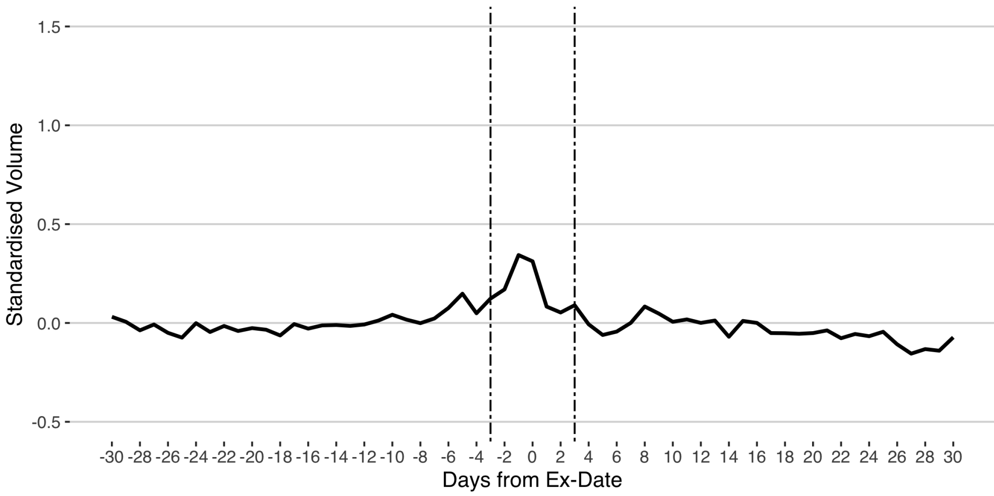

Figure 3.20: *Norway Standardised Volume*

3.4.13 Estonia

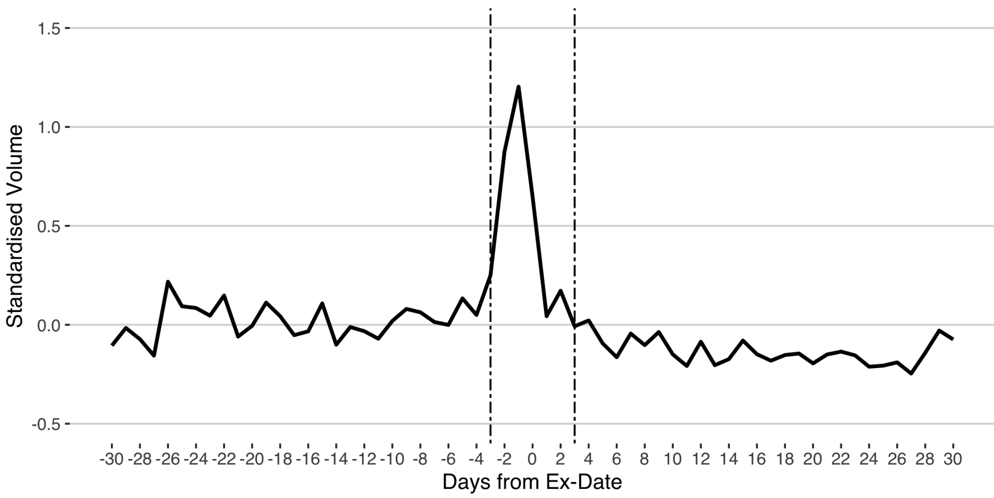

Figure 3.21: *Estonia Standardised volume*

The Estonian market is relatively small compared to the other countries we analyse; we only have 23 dividend-paying companies listed on the main exchange. Estonia has been included because it is the only country we could analyse that has gone from having a DWT and eliminated it in the period. In 2010, Estonia removed DWT and was not levying DWT until 2018. When re-implementing DWT in 2018, the rate was much lower than the rate in 2009, from 21% to 7% general DWT rate, and this rate only occurs for some individual investors (EY, 2020). The removal of DWT means that, like in the UK, DWT schemes are not possible.

The volume plot in Estonia in Figure 3.21 show clear indications of abnormal volume around the ex-date, over the level we expect from regular excess trading around the dividend settlement. In ex-1, the mean volume for the entire period is 1.203 s.d., which is the highest for any country in our sample. If we limit the observations to only before the removal of DWT, the standard deviation is much higher at 1.737, which is the highest we have observed in all the volume plots by a large margin. The period from 2010 to 2017 with no DWT also show an increase in the volume at 0.917 s.d. in ex-1, which we cannot explain. Comparing to the UK, which also had no DWT in the same period and has no increase in volume, we expected to see the same pattern in Estonia, but instead, we see a large spike in the period after DWT was removed. The drop in excess volume after the removal of DWT is still interesting.

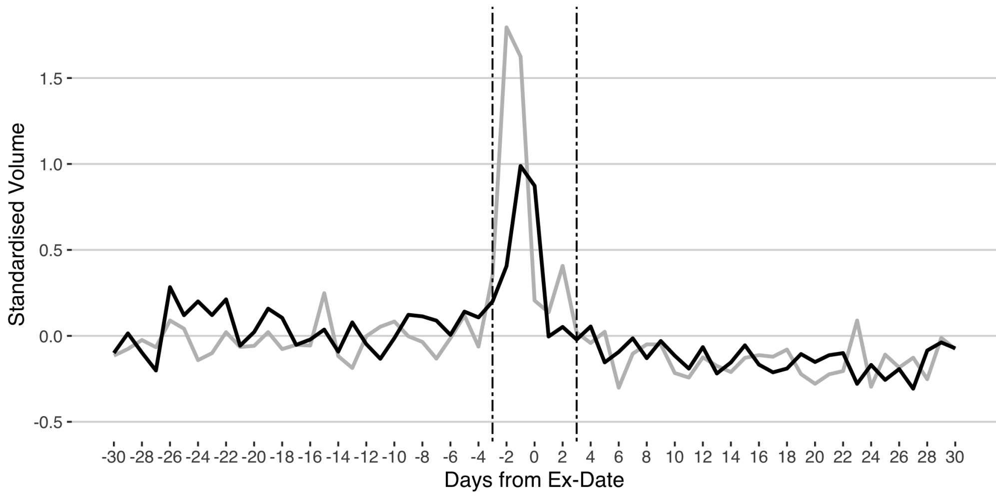

Figure 3.22: *Estonia Standardised volume before (grey) and after 2010 when they removed the DWT (black)*

The transition from having a DWT to not taxing dividends in Estonia can be seen in Figure 3.22, with the grey line showing the period before removing the tax and the black line showing the volume after. The abnormal volume has decreased after the removal of DWT. We see this as an indication that the DWT schemes may also have been present in Estonia. However, Estonia has a dividend clearing system that makes it more challenging to perform DWT schemes. The companies are reporting to the tax authority all persons receiving dividends (ESMA, 2020), this should make it clear to the tax authorities which investors are entitled to a tax refund. The reporting of dividend recipients makes it more difficult to perform multiple reclaim schemes like cum-ex.

3.4.14 Finland

For Finland, we find no reports of DWT schemes being a major problem. The authorities have uncovered the presence of DWT schemes, and a task force has been assembled with the purpose to outline the scope of the schemes in Finland (VERO, 2019). The volume plot in Figure 3.23 indicates a pattern similar to that of Germany, with a s.d. of 0.7410 in ex-1.

Due to reports by the task force lead by Paula Palukka (VERO, 2019), Finland has implemented legislative measures directly aimed at limiting DWT schemes (ESMA, 2020). However, the implementations are outside of the scope of this thesis. Our data range stops at 2020, and the implementation in Finland came into effect in January 2021, so we will not be able to capture the effect of this change, nor will we need to control for it in the analysis.

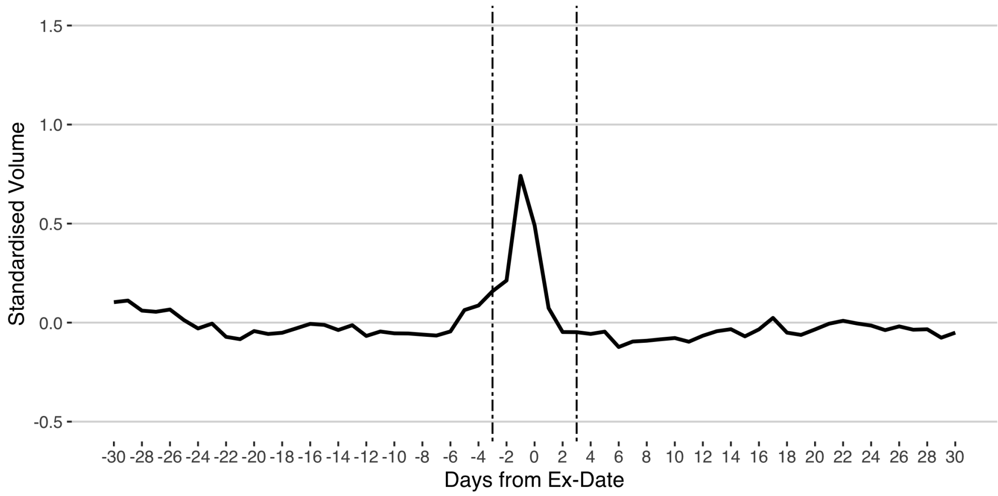

Figure 3.23: *Finland Standardised Volume*

3.4.15 Switzerland

According to sources used by Correctiv (2018), similar cum-ex structures to the ones used in Germany were also possible in Switzerland up until 2008. In 2008 Switzerland implemented adjustments to their legislation, particularly regarding the centralisation of collecting and reimbursement of DWT (Malik, 2020), which should limit cum-ex schemes.

The volume plot in Figure 3.24 shows less excess trading in Switzerland compared to in Germany, with most excess volume at ex-1 with 0.4282 s.d. The DWT rate in Switzerland has been the same at 30% through the entire time period.

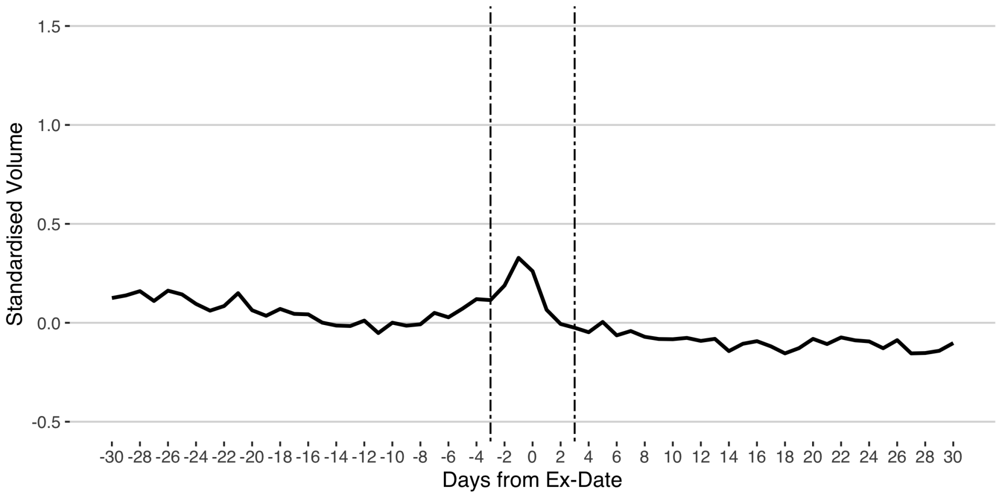

Figure 3.24: *Switzerland Standardised volume*

3.4.16 Summary

To summarise the standardised volume plots, they do not indicate a general increase in excess volume around ex-date following changes in the general DWT rate. Some countries show an indication that supports our hypothesis, but others show the opposite effect of a change in general DWT. We see indications that the DWT rate is not important to an investor looking to partake in collusion. The transition from T+3 to T+2 settlement cycle does appear to support our hypothesis regarding the transition to T+2 settlement cycle. The dates with abnormal volume seem to fit the theory on when the different DWT schemes are possible to execute as discussed in Section 2.5.

4 Methodology

This section will explain the choices we make when transforming the data and determining relevant event windows for the analysis. Further, we develop models to capture the effect of the DWT, settlement cycles, and legislative measures with regards to the DWT schemes we described in Section 2.4. The results from the methods we describe and formulate in this section will then be analysed in Section 5. We have based our methodology on both Blau et al. (2009) and Büettner et al. (2020) since both papers tries to answer similar questions as this thesis, and they utilise similar data. We use Wooldridge (2015) as a reference for our econometric framework.

4.1 Standardisation of daily volume

We calculate the volume by using the closing price and the number of shares traded to measure the total trading volume of the stock in Euros. $V_{i,t} = closing\ price_{i,t} * shares\ traded_{i,t}$. Using this definition of volume, we adjust for the effects of splits or reverse splits occurring within the window. The volume variable, $V_{i,t}$,has been standardised according to Formula 4.1 to ensure equal contribution by the coefficients across all the different dividend distributions, regardless of real volume. Since we use data for several countries, this enables us to compare the data across the borders unaffected by significant differences in volume and volatility caused by both different sized markets and time effects caused by the general increase in trading activity over time. Another benefit of standardising is negating some of the effects of extreme outliers in our models and the effect of big companies driving the volume.

$$S_{i,t} = \frac{V_{i,t} - \bar{V}_i}{\sigma_i} \tag{4.1}$$

$S_{i,t}$ in Formula 4.1 is the standardised volume for distribution i in the distribution period t ranging from [-30,30]. $V_{i,t}$ is the volume for distribution i at time t. $\bar{V}_i$ is the average volume within the distribution. σ_i is the standard deviation for the individual distributions. The outcome of standardising is that every observation, $S_{i,t}$, is transformed to a variable that is displaying the standard deviation away from the mean of the observations within each distribution. $S_{i,t}$ gives us a good measure of excess volume.

4.2 Determining Event Windows

Choosing an appropriate event window for the DWT schemes depends on the method used (e.g. cum-cum or cum-ex) and what settlement cycle the market operates in, as discussed in Section 2.5. To some extent, we can separate the different DWT schemes. However, a fundamental challenge is to isolate excess trade motivated by DWT from other activities around ex-day that is causing excess volume. We choose to run regressions using three event windows to capture different DWT schemes' effect in our models. First, we define the event window similarly to (Blau et al., 2009) as $t \in [-3, 3]$. This window captures both cum-ex schemes and cum-cum schemes as well as repurchase agreements on or after the ex-date. We also choose to use a window that focuses on trades made cum dividend, defined as $t \in [-3, -1]$. Finally, we have also included the window used by Büettner et al. (2020) that only captures the effect of cum-ex trading as $t \in [-2, -1]$. To adjust for the different windows of opportunity, we need to extend the window by one day at the start for all the event windows if the distribution is in a T+3 settlement cycle. The windows in a T+3 system are therefore as following: $t \in [-4, 3]$, $t \in [-4, -1]$ and $t \in [-3, -1]$.

4.3 Econometric Framework

The dataset we will use for analysis is formatted as panel data with each dividend distribution as the cross-sectional dimension and with the time dimension as the [-30,30] window where t=0 is the ex-date. Each distribution then includes the 30 trading days leading up to the ex-date and 30 consecutive days. We can use the days outside the event window to measure excess trade within the event window where the colluders perform most of the DWT schemes. After the cleaning steps and adjustments in Section 3.1.1 we are left with balanced panel data, which means that we have a complete set of observations for every dividend distribution. We include 30 *trading days* before and after the ex-date, which means we have removed observations when the markets are closed, such as weekends or holidays. We have 19,279 distributions with 61 days of observations per distributions. This means we are working with a short and wide panel data set, with a short time period and many observations. In general, there are three different models to estimate coefficients for panel data: Pooled ordinary least squares (Pooled OLS), Fixed Effects (FE) and Random Effects (FE).

Equation 4.2 describes a general illustration of a panel data model for i units over t time. As we can see the error term ($\varepsilon_{i,t}$) consists of three parts. First we have the time dependent error term (v_t), secondly, the unit dependent error term (α_i), and thirdly, the idiosyncratic error term ($u_{i,t}$).

$$\begin{aligned} Y_{i,t} &= \beta_1 + \beta_2 X_{i,t} + \varepsilon_{i,t} \\ \text{Where: } \varepsilon_{i,t} &= v_t + \alpha_i + u_{i,t} \end{aligned} \tag{4.2}$$

The time-dependent error term (v_t) is due to time fixed effects, effects that change over time but are invariant on an entity level. For example, when analysing trading data: trading activity over time is assumed as an effect of economic growth, a time fixed effect. The unit dependent error term (α_i) represents the part of the error term that is unit-specific but does not change over time. For example, when looking at different companies over a time period, it is natural to assume some inherent attributes for individual companies that are constant across time. In the following paragraphs, we make the case that due to the nature of how we have transformed our data, we do not need to include entity fixed or time fixed effects and proceed by using Pooled OLS.

4.3.1 Entity fixed effects

For our data, the unit level (i) is each distribution, and the error term α_i would represent the part of the error term that is constant across distributions and does not change over time. The fixed effects model eliminates this effect by subtracting the mean from each variable in the model; this is known as a within transformation. However, through the standardisation, we have already subtracted the mean of each distribution for every observation. Using standardised volume, we have thus eliminated the unit dependent error term and do not need to include entity fixed effects in our models.

4.3.2 Time fixed effects

Four our data, the time dimension t represents trading days from the ex-date, not chronological time. For any given t in our sample, it will include observations on several dates in our sample period. We can interpret the term v_t as fixed effects in trading time constant for all distributions. Including time fixed effects in our model would be appropriate if we expect fixed effects in the trading patterns around ex-date independent of the distributions. However, we have no theoretical basis for assuming this and therefore argue that there is no reason to include time fixed effects in our model. Even though the time dimension in our data does not represent chronological time, one could still argue that we need to control for effects over chronological time. As an example, we have discussed trading volumes increase over time as a function of economic growth. For the same company, we would expect an increase in volume around ex-date over time as there is a general increase in trading. Such effects could be accounted for by including dummy variables for each year. However, since we have already standardised the volume, this should account for the effect. When we standardise volume, we take the mean *of each distribution*. Therefore we have corrected for the fixed effects of chronological time. In Appendix A2.2 we have plotted our observations over time. As we can see, there is no pattern in the standardised volume over time, as expected. Therefore, we argue that there is no need to control for fixed effects over chronological time.

Based on the preceding discussion, we have corrected for entity fixed effects, effects over chronological time and have no theoretical basis for including time fixed effects. Therefore, we proceed with Pooled OLS for our models.

4.3.3 Clustering of standard errors

We still need to account for the idiosyncratic error term ($u_{i,t}$). We find it likely that there is some correlation between different distributions from the same company, and standardised trading volumes will not account for this. We cluster the standard errors on a company level. Failure to control for within-cluster error correlation can lead to very misleadingly small standard errors. As a consequence, the model will calculate misleadingly narrow confidence intervals, large t-statistics and low p-values (Cameron and Miller, 2015). In Appendix A6 we have included our regression using *Huber-White* robust estimates for achieving robust standard errors. We generally achieve similar standard errors as with clustering on a company level, but the errors are generally somewhat smaller, which is as expected.

4.3.4 Assumptions for Pooled OLS

In order for Pooled OLS estimators to be unbiased, the following conditions must be satisfied:

- **Linearity in parameters:** The model is formulated as a linear relationship between our dependent variable and the coefficients.
- **Random sampling:** The sample is randomly drawn and representative of the true population.
- **No multicollinearity:** There is no exact relationship between the independent variables.
- **Exogenity:** The Zero- conditional mean assumption, that states that the mean of the error term is zero, given the explanatory variables. $E(U|x) = 0$
- **Homoscedasticity:** The error term has the same variance for all explanatory variables. $Var(u|x) = \sigma^2$
- **No autocorrelation:** The error terms are not be correlated.

Our models are linear in parameters by definition. Furthermore, we primarily work with interactions of dummy variables and categorical variables in our models, which makes them linear in variables as well. Random sampling is satisfied as we have included all distributions for the most liquid and dividend-paying companies in each country over the entire sample period.

In Appendix A7 we have included a *Breusch-Pagan/Cook-Weisberg* test for heteroskedasticity for all our regressions. For most of our regressions, we can not reject the null hypothesis of constant variance (Homoscedasticity). Therefore, we need to include robust standard errors. As mentioned, we expect there to be some correlation between distributions made by the same company. As this would violate the assumption of no autocorrelation, we have clustered the standard errors on a company level. This allows for correlation within, but not between the clusters.

With perfect multicollinearity, we would not be able to estimate the coefficients of the perfectly correlated variables. In our models, no variables are perfectly correlated. However, high degrees of multicollinearity can still be a problem. It results in high standard errors and unreliable estimations of the coefficients because it becomes difficult to separate the effects on our dependent variable between the highly correlated variables. In Appendix A8 we have included a VIF test for all our regressions. From the results, we can see that our variables of interest have extremely high VIF values for the tax models. The high VIF values are something we will address further when developing the tax models. We can safely ignore VIF scores under five, which is the case for the remaining models.

Exogenity is a major concern in our models. The existence of omitted variable bias will violate the zero-conditional mean condition, which means the existence of an unobserved variable correlated with one or more of our dependent variables and our explanatory variable. We find it likely that such variables can be present. To minimise the risk of omitted variable bias, we limit the years we include in the regressions when possible. Normality is also required for estimators to be efficient but is not a requirement for unbiased estimators. Normality of residuals means that the error term is normally distributed around zero and is independent of the explanatory variables. We do not expect to meet this assumption, which is confirmed by performing a Shapiro-Wilk W test included in Appendix A9.

4.4 Models

The variables we have used in the following models and their notation are covered in Table 4.1.

Symbol	**Interpretation**
$Y_{i,t}$	Response variable. The models are regressed on $S_{i,t} = \frac{V_{i,t} - \bar{V}_i}{\sigma_i}$
E_t	A dummy variable equal to one if the observation is within the event window.
τ_i	The general DWT rate for distribution i
T_t^{-1}	Dummy variable equal to one if t is one trading day before the event window.
S_i^{T3}	Dummy variable equal to one if the distribution happens under a T+3 system
W_d	Categorical variable for each weekday. d $\in [Monday, ..., Friday]$
λ_i	A dummy variable equal to one if the distribution happens in a country that levies DWT.
C_j	A categorical variable for the different countries. j $\in [AUT, ..., SWE]$
R_i	A dummy variable equal to one if the distributions happens after a reform.
R_i^*	A dummy variable equal to one if the distributions happens after a second reform. After a second reform is included R_i=0. R_i^* Therefore includes the effect of both reforms.

Table 4.1: *Explanation of variables used in the models.*

4.4.1 Dividend Withholding Tax Models

For testing the effect of DWT rates on excess trading around the ex-date, we use two models. First, we use an extensive margin response model, testing if having a DWT will significantly increase our event windows' trading volume, regardless of of the level of the general DWT rate. We also use a model to check the intensive margin response, investigating if increasing the general DWT rate leads to higher excess volume in our event window.

4.4.1.1 Extensive Margin Response Model

$$Y_{i,t} = \beta_1 + \beta_2 \lambda_i E_t + \beta_3 \lambda_i T_t^{-1} S_i^{T3} + \beta_4 E_t + \beta_5 T_t^{-1} S_i^{T3} \varepsilon_{i,t} \tag{4.3}$$

Model 4.3 represents our basic model where the term $\lambda_i E_t$ is the interaction of whether the distribution is subject to a DWT and the event window. The term $\lambda_i T_t^{-1} S_i^{T3}$ is the interaction between whether the distribution is subject to a DWT traded one day before the event window and in a T+3 system. The interpretation of β_2 is how many s.d. away from the mean the observation is if it is within the event window and subject to a DWT, all else equal. The interpretation for β_3 is how many s.d. away from the mean we expect an observation to be if it is made one trading day before the event window, is made in a T+3 system and is subject to a DWT, all else equal. We expect both β_2 and β_3 to be positive as it should not be possible to execute DWT-schemes without a DWT. The terms E_t and $T_t^{-1} S_i^{T3}$ are included to pick up the excess trading in the event window and in the extended window that changes in the general DWT rate cannot explain. The interpretation of β_4 and β_5 is by how many s.d. away from the mean we expect an observation to be if it is respectively in the event window and one day before the event window, and the distribution is made in a T+3 system, all else equal. As there are other reasons for trading around the ex-date not related to DWT, we expect both coefficients to be positive.

$$\begin{aligned} Y_{i,t} =& \beta_1 + \beta_2 \lambda_i E_t + \beta_3 \lambda_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t + \beta_{5,j} C_j T_t^{-1} S_i^{T3} \\ &+ \beta_{6,j} C_j E_t R_i + \beta_{7,j} C_j E_t R_i^* + \beta_{8,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t} \end{aligned} \tag{4.4}$$

Model 4.3 builds on the basic models but is expanded to control for heterogeneity between countries and heterogeneity within countries. The interaction $C_j E_t$ is included instead of the term E_t from model 4.3. This is to correct for abnormal trading in the event window specific to the different countries, as we expect different levels of abnormal trading around the ex-date for different countries. $\beta_{4,j}$ will give us j coefficients interpreted the same way as β_4 in Equation 4.3, for each country in our sample. Likewise, $\beta_{5,j}$ have the same interpretation as β_5 but with coefficients for each country has have distributions in a T+3 system.

We also add several variables to control for heterogeneity within countries. The terms $C_jE_tR_i$, $C_jT_t^{-1}S_i^{T3}$ and $C_jT_t^{-1}S_i^{T3}R_i$ are included to control for the effect of different reforms to combat DWT schemes. $\beta_{6,j}$ can be interpreted as for j countries, how many s.d. away from the mean the observation is if it is within the event window and the distribution is made after a reform is implemented, all else equal. $\beta_{7,j}$ is included because Germany has introduced two reforms. Alternatively, it could have been written as $\beta_{7,DEU}$ since it is only relevant in Germany. It is interpreted as s.d. away from the mean for an observation made in Germany, if it is in the event window, after two introduced reforms, all else equal. $\beta_{8,j}$ is interpreted as for j countries s.d away an observation will be if it is made one day before the event window, in a T+3 system and after a reform, all else equal. As there are no distributions in a T+3 system, with two reforms, we do not need to add a term to control for this. We expect all three coefficients to be negative for countries where reforms have been introduced. Furthermore, we expect $\beta_{7,DEU}$ to be lower than $\beta_{6,DEU}$ as two reforms introduced should reduce excess volume more than one reform. It should be noted that treating the reforms as a dummy variable assumes a linear relationship before and after a reform is introduced. If, for instance, the effect of a reform increases over time after implementation, our model will not account for this. Leading to underestimated coefficients for $\beta_{6,j}, \beta_{7,j}$ and $\beta_{8,j}$.

4.4.1.2 Intensive Margin Response Model

$$\begin{aligned} Y_{i,t} =&\beta_1 + \beta_2\tau_iE_t + \beta_3\tau_iT_t^{-1}S_i^{T3} + \beta_{4,j}C_jE_t + \beta_{5,j}C_jT_t^{-1}S_i^{T3} \\ &+ \beta_{6,j}C_jE_tR_i + \beta_{7,j}C_jE_tR_i^* + \beta_{8,j}C_jT_t^{-1}S_i^{T3}R_i + \varepsilon_{i,t} \end{aligned} \tag{4.5}$$

Model 4.5 builds on Model 4.4. The only difference is that λ_i, have been replaced by τ_i as we want to investigate the intensive-margin response of the general DWT-rate. This changes the interpretation of β_2 and β_3. The interpretation of β_2 is now for one percentage point increase in the general DWT rate; s.d. away from the mean in the event window, all else equal. β_3 is now interpreted as for one percentage point increase in the general DWT rate; s.d. away from the mean for an observation one day before the event window in a T+3 system, all else equal. As we have discussed in Section 2.7 we do not expect changes in the general DWT rate to affect cum-ex trading, but we believe it could affect cum-cum trading. Therefore, we expect β_2 and β_3 to be close to zero in the cum-ex window. For the windows that include cum-cum trading, the coefficients could be positive. However, in our descriptive analysis in Section 3.4 we find no clear indication of increased trading volume after increased general DWT rates.

4.4.1.3 Multicollinearity Issues

As mentioned, high degrees of multicollinearity produces large standard errors and unreliable coefficients. Further investigating this problem, we find that our models struggle with separating the effect on the volume between our variables of interest and the control variables for excess trading in the event window for each country. For the intensive margin response model, this makes sense. All our observations that are not subject to a DWT are in the UK and Estonia. To address this issue we also run an alternative model, Model 4.6 for the extensive margin response, where we drop the terms $C_j E_t$ and $C_j T_t^{-1} S_i^{T3}$. This model does not control for country-specific effects but removes the multicollinearity problem. This model is still useful for our purposes as it will give us a general answer for whether a distribution is subject to a DWT results in higher trading volumes around the ex-date.

$$\begin{aligned} Y_{i,t} =&\beta_1 + \beta_2 \lambda_i E_t + \beta_3 \lambda_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t R_i \\ &+ \beta_{5,j} C_j E_t R_i^* + \beta_{6,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t} \end{aligned} \tag{4.6}$$

We have not run a similar model for the intensive response model. The reason for this is that by eliminating the country-specific effects, we would only produce a model that explains whether countries with a higher general DWT rate have more excess volume. Not whether increases in general DWT results in higher excess trading, which is the purpose of the model. Our model struggles with separating the effect of our tax variables and the necessary control variables for the different countries, which provide some valuable insights. If we assume that changes in the general DWT rate within countries result in increased excess trade, the model will be able to separate this effect from the country fixed effects.

The fact that we cannot separate the two effects indicates that our tax variables only can explain differences in DWT between countries, implying that changes in the general DWT rate within countries have close to no effect on excess volume.

4.4.2 Settlement change Model

The model 4.7 is an adjustment of the previous models designed to investigate what happens with trading at ex-3 when a country transitions from a T+3 to a T+2 system. Our variable of interest is a new term we have included, $T_t^{-1} S_i^{T3} C_j$, which captures the effect of trading at ex-3 in a T+3 system in the different countries. The coefficient $\beta_{2,j}$ is interpreted for j countries; how many s.d. away from the mean is an observation if it happens at ex-3 in a T+3 system, all else equal.

$$\begin{aligned} Y_{i,t} =& \beta_1 + \beta_{2,j} T_t^{-1} S_i^{T3} C_j + \beta_{3,j} E_t C_j + \beta_{4,j} R_i E_t C_j \\ &+ \beta_{6,j} R_i^* E_t C_j + \beta_{7,j} R_i T_t^{-1} S_i^{T3} + \beta_{8,d,j} W_d C_j + \varepsilon_{i,t} \end{aligned} \tag{4.7}$$

As covered in Section 2.3 and 4.2, the window of opportunity for DWT schemes is different in a T+3, compared to a T+2 settlement cycle. When transitioning to a T+2 settlement cycle, the last date for executing a DWT scheme that is traded and delivered cum-dividend moves from ex-4 to ex-3, and the cum-ex window shortens to exclude ex-3. All else equal, we expect the following:

- If cum-cum is more prevalent in the market than cum-ex, trading at ex-3 should be *Lower* in a T+3, compared to a T+2 settlement cycle. $\beta_{2,j}$ will therefore be *negative.*
- If cum-ex is more prevalent in the market than cum-cum, trading at ex-3 should be *Higher* in a T+3, compared to a T+2 settlement cycle. $\beta_{2,j}$ will therefore be *positive.*

This model also differs from the previous models with the term $W_d C_j$ as in some countries. The record date typically happens on specific weekdays. If we did not include this term, we would under or overestimate the effect of $\beta_{2,j}$ as it would include the effect of the ex-date moving systematically from one weekday to another, as we discussed in Section 3.4. The interpretation of $\beta_{8,j,d}$ is how many s.d. away from the mean in country j for weekday d, all else equal. However, as having a DWT seems important, we have also treated the Estonian elimination of DWT in 2011 as a reform to control for this effect.

4.4.3 Effect of Reforms Model

To investigate if the different reforms in European countries have had an effect on excess trade in the different windows, we have developed Model 4.8 that we run on the countries that have implemented reforms directly aimed at limiting DWT schemes. We run this model on the countries that have introduced legislative measures to close the opportunities for either cum-cum, cum-ex, or both. The reforms are discussed in Section 3.4 and a summary of the reforms are included in Appendix A5.1. In addition, we also look at the Estonian elimination of DWT. For an overview of the reforms, see Appendix A5. As mentioned Section 4.3.4, we find it unlikely that we can control for all the changes over time within countries that can have an effect on excess trade in the event window. We, therefore, perform our regression on each country individually for three years before and after the reforms are introduced, as this reduces the risk of omitted variable bias. We use a shorter post- and pre-effect window for the most recent reforms, as we do not have three years of observations for reforms after 2017.

$$Y_{i,t} = \beta_1 + \beta_2 R_i E_t + \beta_3 E_t + \varepsilon_{i,t} \tag{4.8}$$

The model includes only two terms. Our variable of interest is $R_i E_t$ as it measures the change in excess volume in the event window after a reform. β_2 is interpreted as how many s.d away from the mean an observation is if it is within the event window after a reform, all else equal. The dummy variable for the event window, E_t, is included not to overestimate the effect of β_2. β_3 is interpreted as how many s.d away from the mean an observation is if it is within the event window, all else equal. We expect β_3 to be positive as there is excess trade around the ex-date, both caused by DWT schemes and other reasons. β_2 is expected to be negative as reforms should lead to less trading in the windows. If the reforms are ineffective or if there is little or no DWT schemes in the market before the reform, we expect β_3 to be close to zero.

5 Analysis

Following the methods described in Section 4, and the models we have developed to determine the effect of DWT, the effect of trading at ex-3 when the settlement cycle changes from T+3 to T+2 and the effect of attempts to limit DWT schemes in different countries through legislative changes. This section presents the results of the different models and discusses their weaknesses.

5.1 Dividend Withholding Tax Models

5.1.1 Extensive Margin Response Model

Regression is specified as Model 4.4:

$$Y_{i,t} = \beta_1 + \beta_2 \lambda_i E_t + \beta_3 \lambda_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t + \beta_{5,j} C_j T_t^{-1} S_i^{T3}$$
$$+ \beta_{6,j} C_j E_t R_i + \beta_{7,j} C_j E_t R_i^* + \beta_{8,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$$

	(1)	(2)	(3)
Event window	$t \in [-3, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$
Extended event window	$t = -4$	$t = -4$	$t = -3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\lambda_i E_t$	0.572***	0.236**	0.770***
	(0.181)	(0.107)	(0.254)
$\lambda_i T_t^{-1} S_i^{T3}$	-0.00378	-0.00378	0.162
	(0.0758)	(0.0758)	(0.253)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.008	0.010	0.008
Country FE	YES	YES	YES
Reform FE	YES	YES	YES
Clustered SE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.1: *Regression results from extensive margin response model.*

In Table 5.1, we can see the results of the regression of Model 4.4, and in Table 5.2 we can see regression of Model 4.6 for the three different event windows, with coefficients and standard errors for our variables of interest included in parentheses. The null hypothesis for the corresponding p-values is that $\beta_i = 0$, i.e. no effect on excess volume. We can see from Table 5.1 that the coefficients for the variable $\lambda_i E_t$ are positive significant at a 5%

or lower for all three windows in both versions of the model. The results indicate that having a DWT leads to increased volume around the ex-date, in line with our hypothesis that DWT schemes are impossible without a DWT. From the coefficients, we also observe that the effect is higher in the cum-ex window compared with the windows that also include cum-cum trading in both models. This can indicate that cum-ex schemes are more prevalent than cum-cum, but it can also be because cum-cum trading is not equally limited to an event window.

For the variable covering trading one day before our window, when the distribution happens in a T+3 system, we obtain no significant results when including country fixed effects. When we exclude the country-specific terms, we obtain relatively large positive coefficients for ex-4 and ex-3, which aligns with our theory. However, the excess volume in the extended window is smaller than the increase within the window. In summary, these results indicate that having a DWT imposed on the investors leads to increased trading around the ex-date.

Regression is specified as Model 4.6:

$$Y_{i,t} = \beta_1 + \beta_2\lambda_i E_t + \beta_3\lambda_i T_t^{-1} S_i^{T3}$$
$$+\beta_{4,j} C_j E_t R_i + \beta_{5,j} C_j E_t R_i^* + \beta_{6,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$$

	(4)	(5)	(6)
Event window	$t \in [-3,-1]$	$t \in [-3,3]$	$t \in [-2,-1]$
Extended event window	$t = -4$	$t = -4$	$t = -3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\lambda_i E_t$	0.390***	0.307***	0.457***
	(0.0140)	(0.0107)	(0.0166)
$\lambda_i T_t^{-1} S_i^{T3}$	0.240***	0.253***	0.250***
	(0.0219)	(0.0221)	(0.0178)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.006	0.008	0.006
Country FE	NO	NO	NO
Reform FE	YES	YES	YES
Clustered SE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.2: *Regression results from extensive margin response model, not including country specific fixed effects*

5.1.2 Intensive Margin Response Model

Regression is specified as Model 4.5:

$$Y_{i,t} = \beta_1 + \beta_2 \tau_i E_t + \beta_3 \tau_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t + \beta_{5,j} C_j T_t^{-1} S_i^{T3} + \beta_{6,j} C_j E_t R_i + \beta_{7,j} C_j E_t R_i^* + \beta_{8,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$$

	(7)	(8)	(9)
Event window	$t \in [-3,-1]$	$t \in [-3,3]$	$t \in [-2,-1]$
Extended event window	$t = -4$	$t = -4$	$t = -3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\tau_i E_t$	-0.00802*	0.00168	-0.00804
	(0.00447)	(0.00242)	(0.00560)
$\tau_i T_t^{-1} S_i^{T3}$	-0.00513	-0.00513	-0.00937
	(0.00523)	(0.00523)	(0.00584)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.008	0.010	0.008
Country FE	YES	YES	YES
Reform FE	YES	YES	YES
Clustered SE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.3: *Regression results from intensive margin response model*

In Table 5.3, we can see the results of the regression of Model 4.5 for the three different event windows. As we can see from the printout, the coefficients for the variable $\tau_i E_t$ is significant in the $t \in [-3-1]$, but only at a 10% threshold. All the other coefficients require a higher threshold to reject the null hypothesis. The coefficients for the $t \in [-3,-1]$ and $t \in [-2,-1]$ windows are slightly negative, contradictory to our hypothesis. To summarise, our model cannot prove a significant relationship between excess trade around dividend day and the level of the top DWT rate.

As mentioned in Section 4.3.4, the model suffers from multicollinearity issues we are not able to resolve as it would require removing the country-specific variables. As discussed, we would not expect such a severe multicollinearity problem if there, in fact, was a relationship between excess volume and changes in the general DWT. From the results, we observe standard errors close to or larger than our estimated coefficients, illustrating the model's inefficiency.

A further problem with our analysis is whether the general DWT rate is a meaningful measurement. As we covered in Section 2 DWT rates are complex. There are several exceptions from the general DWT through double taxation treaties. A more thorough investigation would need to consider the effect of these treaties. Furthermore, the extent of shareholders subject to the general DWT rate will also differ between countries as long as the distribution of nationalities of shareholders is not equal across countries and companies. In summary, our analysis does not indicate that DWT schemes increase with the general DWT.

Summary of DWT Models

In summary, our investigation into the effect of DWT indicates that there is an extensive margin response on both cum-cum and cum-ex trading. We find no intensive margin response for neither cum-cum nor cum-ex trades. The results indicate that whether a country imposes a DWT on the investors appears to be important. However, changes in the general DWT rate does not.

5.2 Settlement Changes

In Table 5.4 we present the results of the regression of Model 4.7. As the UK does not levy a DWT on foreign investors, it is by definition not possible to deploy any DWT schemes in the UK. This means that we can interpret the coefficient in the UK as a proxy for how we would expect trade to change at ex-3 when the settlement cycle changes for a country that is not affected by DWT schemes. To check if coefficients are statistically different from the UK, we have performed a F-test[6] on our statistically significant coefficients in other countries compared with the UK. The coefficients that the F-test returns as under 5% probability of being equal to $\hat{\beta}_{3,GBR}$ are marked in bold. However, there could also be country-specific effects for changing in trading due to changes in the settlement cycle in the UK not included in our model. Therefore, it would be wrong to disregard coefficients in other countries that are not significantly different from the UK. Our data includes observations from 2004 to 2020. Considering the long period, it is likely that there have been other changes within countries that affect trading patterns around the ex-date.

[6]F-test is formulated as: $H_o : \hat{\beta}_{2,j} = \hat{\beta}_{3,GBR}$. For j countries, except GBR

Regression is specified as Model 4.7: $Y_{i,t} = \beta_1 + \beta_{2,j} T_t^{-1} S_i^{T3} C_j + \beta_{3,j} E_t C_j + \beta_{4,j} R_i E_t C_j + \beta_{6,j} R_i^* E_t C_j + \beta_{7,j} R_i T_t^{-1} S_i^{T3} + \beta_{8,d,j} W_d C_j + \varepsilon_{i,t}$		
	(10)	(11)
Event Window	$t \in [-2, -1]$	$t \in [-2, -1]$
Extended Event Window	$t = -3$	$t = -3$
Years Included	2004-2020	2013-2016
Estimation Method	Pooled OLS	Pooled OLS
VARIABLES		
$T_t^{-1} S_i^{T3} * AUT$	**0.0412**	0.0107
	(0.0492)	(0.106)
$T_t^{-1} S_i^{T3} * BEL$	0.151***	0.0947
	(0.0388)	(0.0994)
$T_t^{-1} S_i^{T3} * CHE$	0.0554	0.225***
	(0.0632)	(0.0675)
$T_t^{-1} S_i^{T3} * DNK$	**0.0133**	-0.0349
	(0.0395)	(0.0778)
$T_t^{-1} S_i^{T3} * ESP$	**0.384*** **	0.106**
	(0.0416)	(0.0519)
$T_t^{-1} S_i^{T3} * EST$	0.387*	0.283
	(0.205)	(0.281)
$T_t^{-1} S_i^{T3} * FIN$	0.145***	0.0994
	(0.0393)	(0.0869)
$T_t^{-1} S_i^{T3} * FRA$	0.0782***	0.00716
	(0.0300)	(0.0542)
$T_t^{-1} S_i^{T3} * GBR$	0.159***	0.110
	(0.0316)	(0.0752)
$T_t^{-1} S_i^{T3} * ITA$	**0.888*** **	**0.663*** **
	(0.0754)	(0.120)
$T_t^{-1} S_i^{T3} * NLD$	0.183***	0.175**
	(0.0403)	(0.0881)
$T_t^{-1} S_i^{T3} * NOR$	0.134***	0.0963
	(0.0507)	(0.104)
$T_t^{-1} S_i^{T3} * SWE$	0.210***	0.0464
	(0.0421)	(0.0618)
Observations	1,176,141	283,905
R-squared	0.018	0.018
Country FE	YES	YES
Reform FE	YES	YES
Weekday FE	YES	YES
Clustered SE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.4: *Regression results for the effect of settlement cycle model. In bold: Coefficients that are statistically different from the United Kingdom at a 5 % significance level.*

To reduce the possibility of omitted variable bias, we also run our regressions on a subset of the data, using observations between 2013 to 2016. As the settlement changes occur towards the end of 2014 for all countries, this should give us enough observations before and after the settlement change to measure the effect of the transition.

As we can see from the results, all coefficients except for Denmark in the smaller subset is positive. From our hypothesis, we would expect positive coefficients if cum-ex trading is more prominent in the market than cum-cum trading, all else equal. However, few of the observations are significant in addition to being significantly different from the United Kingdom. The most interesting results are the coefficients for Italy. We find a pretty high increase in volume at 0.888 and 0.663 s.d. from the mean. The coefficients are significant at a 1% threshold in both windows and statistically different from the UK. Following our earlier discussion in Section 4.2 this could be an indication cum-ex trading in a T+3 system that will move away from ex-3 when transitioning to a T+2 settlement system.

A major weakness of the model is that we limited knowledge of the relative extent of cum-cum trading and cum-ex trading in the markets. If both schemes are present simultaneously, with similar volumes (with cum-cum traders executing their deals as close to ex-date as possible), we expect the two effects to cancel each other out. Holding other effects around ex-day constant, we would expect coefficients to be zero under this scenario. In summary, our analysis of settlement changes is inconclusive.

In summary our analysis of trading at ex-3 when a country changes from a T+2 to a T+3 settlement cycle is inconclusive Although outside the scope of this thesis, the changes, especially in Italy, would be interesting to investigate further.

5.3 Effect of reforms

Table 5.5 presents the regression results of Model 4.8 investigating the effect of various reforms in European countries, including the elimination of DWT in Estonia in 2010. For this model, we have applied a $t \in [-3, 3]$ window and a $t \in [-2, -1]$ window as we want to be able to say something about the effect of the reforms on both cum-cum and cum-ex trading. This analysis refers to the event windows as the cum-cum window for $t \in [-3, 3]$ and the cum-ex window for $t \in [-2, -1]$.

Regression specified as Model 4.8:
$Y_{i,t} = \beta_1 + \beta_2 E_t + \beta_3 R_i E_t + \varepsilon_{i,t}$

	(12)	(13)	(14)	(15)	(16)	(17)
Event window	$t \in [-3, 3]$	$t \in [-2, -1])$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$
Country	AUT	AUT	BEL	BEL	DNK	DNK
Reform Year	2015	2015	2019	2019	2016	2016
Years inclunded	2012- 2017	2012- 2017	2017-2020	2017-2020	2013- 2018	2013-2018
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.0951*	-0.203**	-0.237***	-0.352***	0.0383	0.0973
	(0.0526)	(0.0921)	(0.0515)	(0.111)	(0.0630)	(0.109)
Observations	13,925	13,925	19,046	19,046	21,198	21,198
R-squared	0.001	0.001	0.008	0.005	0.004	0.004
Clustered SE	YES	YES	YES	YES	YES	YES

	(18)	(19)	(20)	(21)	(22)	(23)
Event window	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-3, 3]$
Country	FRA	FRA	CHE	CHE	NOR	NOR
Reform Year	2019	2019	2008	2008	2019	2019
Years inclunded	2018- 2020	2018- 2020	2005- 2010	2005- 2010	2017- 2020	2017- 2020
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.0851	-0.231**	0.0706*	0.0677	-0.0635	-0.0333
	(0.0649)	(0.0961)	(0.0399)	(0.0690)	(0.0715)	(0.115)
Observations	15,392	15,392	28,193	28,193	18,512	18,512
R-squared	0.004	0.003	0.002	0.001	0.004	0.005
Clustered SE	YES	YES	YES	YES	YES	YES

	(24)	(25)	(26)	(27)	(28)	(29)
Event window	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$
Country	EST	EST	DEU	DEU	DEU	DEU
Reform Year	2010	2010	2012	2012	2016	2016
Years inclunded	2007- 2012	2007- 2012	2009- 2014	2009- 2014	2013- 2018	2013- 2018
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.449***	-0.658**	-0.151***	-0.417***	-0.0893**	-0.0193
	(0.128)	(0.278)	(0.0519)	(0.118)	(0.0404)	(0.0732)
Observations	2,867	2,867	30,975	30,975	33,947	33,947
R-squared	0.023	0.025	0.022	0.026	0.012	0.013
Clustered SE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.5: *Regression results of the reform model.*

For the Austrian reform of 2015, we find a significant reduction in trading in both windows. However, the coefficient for the cum-ex window is much higher and significant at a 5% threshold. The results suggest that the reform has had an effect on reducing cum-ex trading, in line with the reform objective. For the 2019 Belgian tax reform, we obtain statistically significant coefficients for both windows at a 1% threshold. In the cum-cum window, the reduction is around -0.2 standard deviations and -0,4 in the Cum-Ex window. These results indicate that the reform has been effective at reducing both cum-cum and cum-ex trading. However, it is not possible to say that the reform has been more effective at reducing cum-ex than cum-cum trading. It would depend on the relative ratio of the different trades existing in the market, which is difficult to determine.

The Danish tax reform of 2016 was designed to limit both cum-cum and cum-ex schemes. Our model produces insignificant coefficients for both windows. However, this can be explained by the fact that reportedly most of the later DWT schemes in Denmark were executed through the cum-fake method. These schemes would not affect volume in our data (Wigan, 2019). The Norwegian reform in 2019 is similar to the Danish reform show a small decrease for both window, and the coefficients are not significant at a 10% threshold for any of the windows, similar to the results in Denmark. This could indicate that the reform has not been successful. However, it could also be little DWT schemes in both countries before the reform. In Norway, this makes sense since the authorities allegedly stopped several attempts at DWT schemes after uncovering one successful attempt in 2013.

The 2008 reform in Switzerland does not appear to have had any effect. In fact, the coefficients in both windows indicate a slight increase in volume after the reform. However, the coefficient in the cum-cum window is only significant at a 10% threshold. For the cum-ex window, the threshold is higher. We have limited information on both the reform and DWT-schemes in general in Switzerland. We therefore have no explanation as to why the reform appears to not have had any effect.

The French tax reform of 2019 is similar to the aforementioned Belgian reform, limiting both cum-cum and cum-ex transactions. We find no significant reduction in the cum-cum window. However, there is a significant reduction, at a 5% threshold, in the cum-ex window. This is an interesting result as it contradicts the French authorities' claim that cum-ex trades have never been possible in the French market (ESMA, 2020).

Finally, we have included the two reforms in Germany, the first in 2012 aimed at limiting cum-ex trading, the subject of the Büettner et al. (2020) article. Furthermore, the 2016 tax reform aimed at limiting cum-cum trading. For the 2012 reform, we find a significant reduction in volume in the cum-ex window, consistent with the findings of Büettner et al. (2020). We also find a significant reduction in the cum-cum window. However, this is naturally driven by reductions in the cum-ex window since this window is also included for the cum-cum window. For the 2016 reform, we find no significant effect on the cum-ex window. For the cum-cum window, the coefficient is significant at a 5% threshold; and indicates a slight reduction in cum-cum trading after the reform.

We have also investigated the effect of the Estonian elimination of DWT in 2010. We observe a large decrease in volume in both windows after the elimination of DWT. The coefficients are significant at a 1% threshold for the Cum-cum window and a 5% threshold for the cum-ex window. This is in line with our theory as after the elimination of DWT, DWT schemes should not be possible. This is also in line with the results of our extensive margin response model. Whether a country has a DWT leads to increased volume around the ex-date.

In summary our results show a significant reduction in excess trading around the ex date for all reforms, with the exception of the reforms in Denmark, Norway and Switzerland.

5.4 General Weaknesses

One apparent weakness in our analysis is the numerous other reasons for abnormal volume and isolating the abnormal volume caused by DWT schemes. We only look at volumes aggregated daily, but if we had available data on single trades, we would most likely identify suspicious behaviour and could more accurately isolate the tax-motivated trades. This would mean a lot more data for each country since the daily aggregates include thousands of single trades. In the analysis by Büettner et al. (2020), the data also contained non-taxable dividends. We did not have this kind of data available. If we could run our models with non-taxable dividends, we could use them as a control variable as they should not be affected by changes concerning DWT schemes.

Another challenge is the fact that we are dealing with a dataset that spans over 16 years. We have adjusted for the major reforms we could find that aim to limit DWT schemes. However, we find it likely that there have been other legislative and institutional changes to limit DWT schemes and changes that would affect trading patterns not related to DWT schemes around ex-date. The existence of reforms not included in the analysis would introduce missing variable bias into our model. It is likely correlated with our response variable and our explanatory variable, particularly the event-window dummies. This is of major concern as the existence of an omitted variable is a violation of the exogenity assumption and would lead to biased estimators.

6 Conclusion

This thesis explores the DWT schemes that have caused considerable losses to European tax treasuries in recent decades. We have, for each country, presented a brief introduction to the estimated losses caused by DWT schemes, loopholes that allow for collusion, legislative changes to limit DWT schemes. Through our econometric framework, we have looked at the effect of having a DWT and if changes in the general DWT rate have affected abnormal volume around the ex-date. In addition, we have looked at the effect of the transition from a T+3 to a T+2 standard settlement cycle and the effects of different countries legislative measures introduced to limit DWT schemes.

As we researched the different countries' taxing policies and legislation regarding the DWT, it became clear that the changes in the general DWT rate are an inadequate measure to explain abnormal trading volumes within the DWT-scheme windows. We find no evidence supporting the hypothesis that changes in the general DWT rate has an effect on excess volume. The complexity in how the DWT is calculated related to different tax treaties makes it essential to know where the individual trade originates, requiring much more detailed data than included in this thesis. A superficial analysis of each country's legislation and information gathered on how the colluders are operating revealed that the colluders tend to focus on the jurisdictions where the DWT schemes are both easier to perform and with less risk of penalisation. Even though changes in the general DWT rate is not important, we find that whether a country has a DWT or not is important. This is confirmed both by our extensive margin response model and our country-specific analysis on the removal of DWT in Estonia.

Our analysis of changes in the settlement cycle is inconclusive, as we do not know the extent of the different DWT schemes prevalence in the period of transitioning from T+3 to T+2 in European markets. The two schemes should, according to theory, have the opposite effect on abnormal volume when transitioning from a T+3 to a T+2 settlement cycle. We generally observe an increase in ex-3 when the distributions made in a T+3 system. This could indicate that cum-ex trading is more prevalent in the market. However, we achieve few statistically significant coefficients and few coefficients statistically different from the UK, leaving our analysis inconclusive. However, we find some interesting results, particularly in Italy, with large positive coefficients, statistically significant at ex-3 in a T+3 system compared to a T+2 system. This result would be interesting to analyse further.

Finally, we looked at the effects of measures aimed at limiting DWT schemes. Our analysis on the effect of 2012 reform in Germany produces similar results as Büettner et al. (2020), with significantly less abnormal volume after the reform. We also find significantly lower volume for reforms in other European markets, except Denmark, Norway, and Switzerland. In general, we can conclude that the measures taken to combat the DWT schemes have led to significantly lower volumes in the event windows for distributions on the main exchange in each country. This indicates that most of the reforms have been successful. However, as discussed in Section 2.6 we cannot rule out that the DWT schemes have been adapted to new legislative measures. A possibility is that the schemes moved to venues that do not affect the volume in the main exchange, like OTC platforms. Generally, we also discover that reforms designed to limit cum-ex trades seems to be more successful than reforms aimed at limiting cum-cum trading. However, this can also be explained by the fact that cum-cum trading can be executed outside our window. In addition, we have limited knowledge regarding the relative extent of the different schemes in the market before the reforms were introduced.

To answer the question in our title; *What Drives the Devil's Machine?* Our analysis indicates the presence of dividend withholding taxes, combined with institutional weaknesses within and across borders; however, increasing the rate does not accelerate it.

6.1 Further Research

For the analysis, gathering data on short interest would be useful. As DWT schemes often are deployed using short sales, this would be a valuable addition to our data. Compustat does not offer data on short ratio, and gathering this information would be very challenging when doing analyses over a large geographical area with several different exchanges. In the future, there will be more publicly available data on short positions. This is because securities listed on an exchange in EFTA countries following the MiFID II / MiFIR regulation, which requires investment banks to report significant short positions to the financial authorities (Finanstilsynet, 2017).

A development we could have made to our models is to calculate dividend yields to investigate if we could find effects for different dividend classes, similar to, e.g. Büettner et al. (2020). However, because we have a cross border dataset, we chose not to do this as it would require a pan-European definition of the different dividend yield classes.

Throughout our analysis, we have uncovered several country-specific results that would be interesting to investigate further. In our analysis of settlement changes, the results in Italy warrant further research. A more comprehensive analysis of the Italian market during the transition to T+2 could provide useful insights into trading around the ex-date in the Italian market.

The Estonian elimination of the DWT in 2011 would make an interesting case as one could build an event study with one period with and a second period without DWT. A more in-depth country-specific investigation looking at whether DWT schemes were possible in Estonia and how the DWT relates to the overall Estonian tax system could provide some exciting results. Even though the market is relatively tiny, Estonia also has the highest levels of abnormal volume within the DWT-scheme windows, which could strengthen the warrant for a thorough analysis of the Estonian market. A further investigation on the effect of eliminating DWT could also be interesting. Estonia is the only European country that has eliminated an existing DWT. If there are countries outside Europe that also have eliminated the DWT, then analysing if DWT schemes are possible in these markets and the effect of eliminating the DWT would be interesting.

Finland is also a country with interesting findings. The volume in Finland shows excess volume around the ex-date similar to Germany. A new legislative measure directly aimed at limiting DWT schemes has been implemented in 2021, thus outside the scope of this thesis as mentioned in Section 3.4.14. Looking at the effect this measure has on abnormal volume would be an excellent addition to the research in the future. Another recent development that would be interesting to investigate further is the effect of the proposed pan-European measures in the European Banking Authority (2020a) 10-point action plan to limit DWT-schemes.

Finally, a more thorough investigation on the effects of the country-specific reforms than our superficial analysis is also warranted. Going more into details for the specific countries, combined with a more granular dataset, one could more accurately measure the reduction of DWT schemes after the reforms. This would also provide a basis for estimating the extent of tax losses associated with DWT trading before the reforms. Furthermore, our analysis assumes that a reform only affects the country in which it is implemented. However, it could be interesting to investigate whether a reform in one country affects other markets. Either by traders moving to find new opportunities or by traders in other markets reducing their trades as the risks of similar legislation and higher awareness by the authorities increases in their countries.

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Appendix

A1 Tables

Country	AUT	BEL	CHE	DEU	DNK	ESP	EST	FIN	FRA	GBR	ITA	NLD	NOR	SWE	SUM
Companies	167	254	486	1507	377	393	34	236	1410	3884	620	342	495	1159	11364
Dividend paying companies	99	169	255	422	186	211	25	187	763	1954	381	189	219	449	5509
Most liquid dividend paying companies	99	100	100	100	100	100	25	100	100	100	100	100	100	100	1324

Table A1.1: *Number of companies, dividend paying companies, and most liquid companies included per country in the analysis by their respective ISO-code*

Country	Monday	Tuesday	Wednesday	Thursday	Friday	Sum
AUT	118	105	119	116	185	643
BEL	227	294	284	256	255	1316
CHE	259	243	327	320	210	1359
DEU	137	251	355	404	293	1440
DNK	290	124	214	102	202	932
ESP	365	382	356	408	404	1915
EST	17	23	31	39	32	142
FIN	337	363	151	241	263	1355
FRA	313	343	371	304	251	1582
GBR	11	68	5	4	3178	3266
ITA	1	415	943	24	3	1386
NLD	217	306	311	223	202	1259
NOR	246	242	163	175	189	1015
SWE	489	320	168	244	448	1669
SUM	3027	3479	3798	2860	6115	**19279**

Table A1.2: *Record date distribution for the sampled countries*

A2 Figures

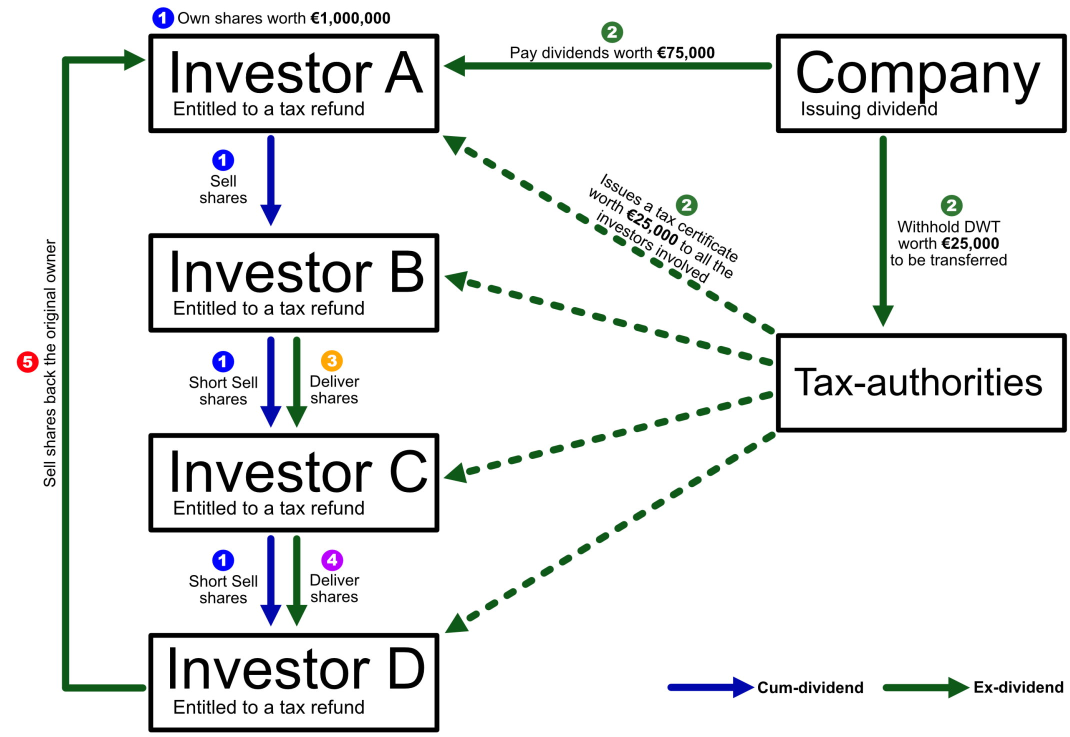

Figure A2.1: *Cum-Ex Multiple Reclaim Example. Source: Own contribution, inspired by Wigan (2019)*

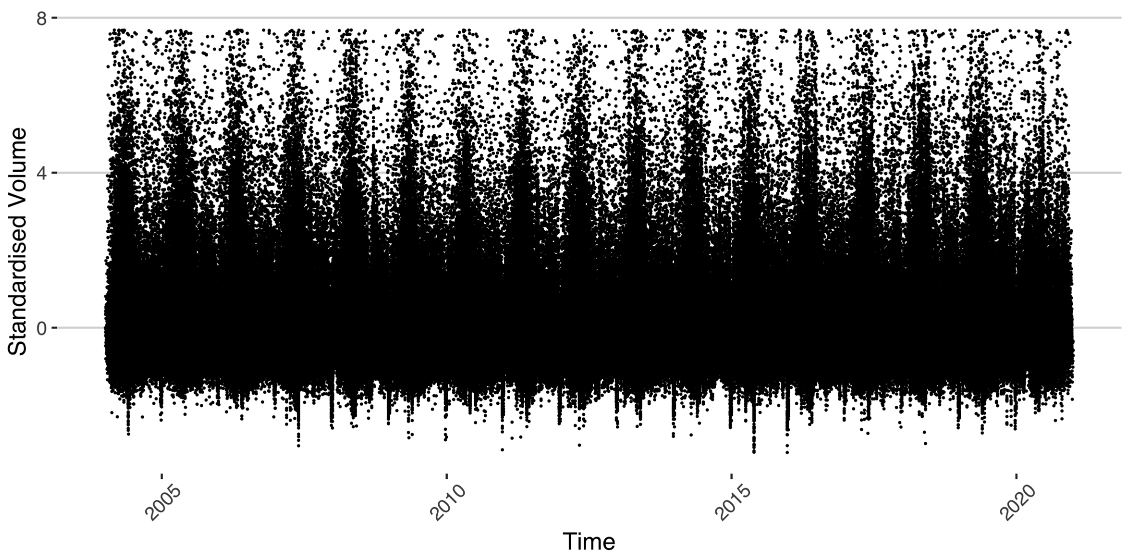

Figure A2.2: *Distribution of all observations over time*

A3 Plots with T+3 and T+2 settlement cycles

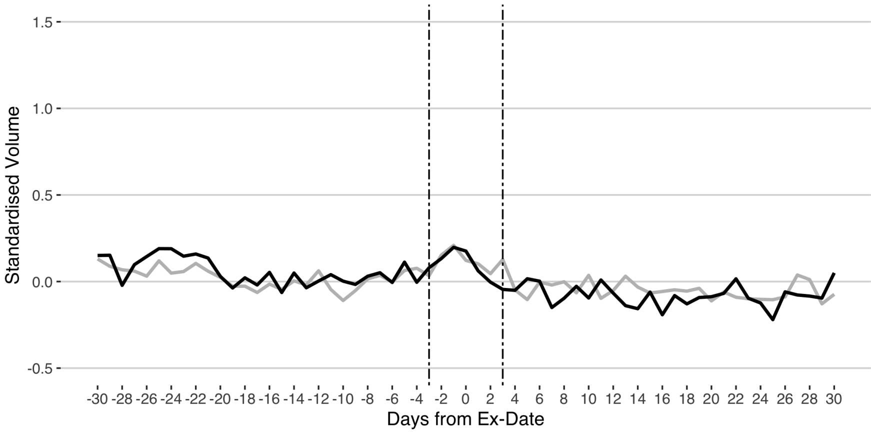

Figure A3.1: *Austria with T+3 (grey) and T+2 (black) standard settlement cycles*

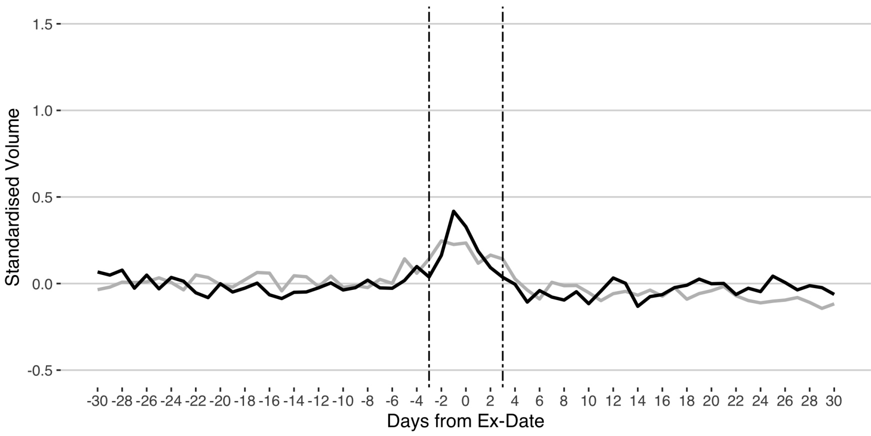

Figure A3.2: *Belgium with T+3 (grey) and T+2 (black) standard settlement cycles*

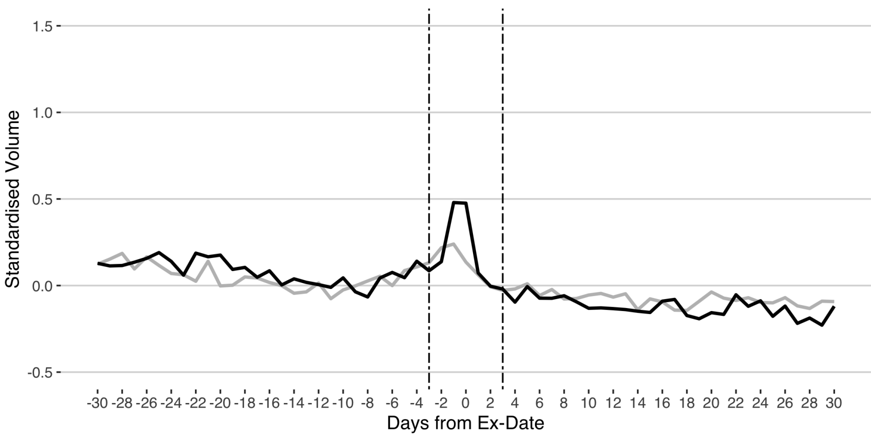

Figure A3.3: *Switzerland with T+3 (grey) and T+2 (black) standard settlement cycles*

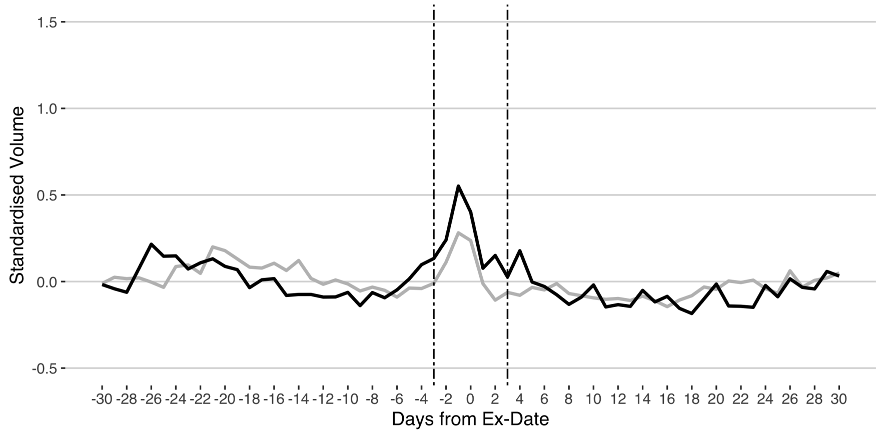

Figure A3.4: *Denmark with T+3 (grey) and T+2 (black) standard settlement cycles*

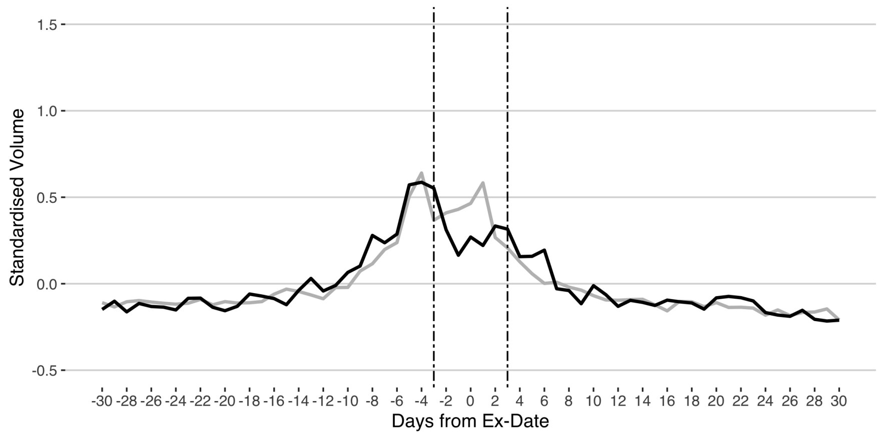

Figure A3.5: *Spain with T+3 (grey) and T+2 (black) standard settlement cycles*

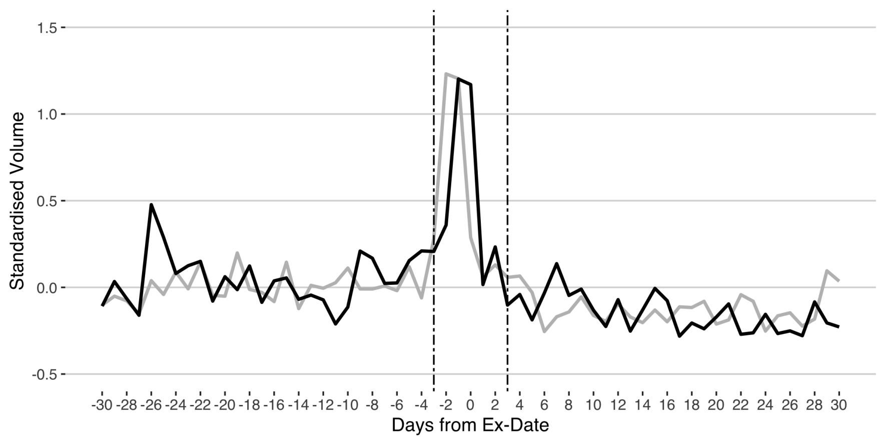

Figure A3.6: *Estonia with T+3 (grey) and T+2 (black) standard settlement cycles*

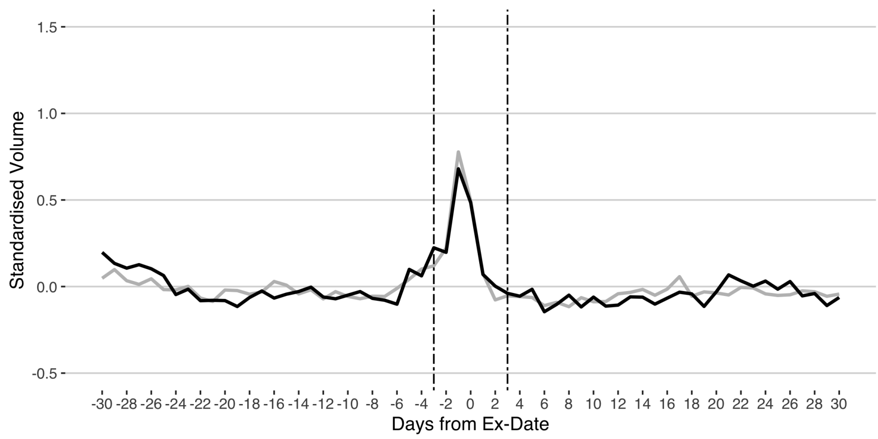

Figure A3.7: *Finland with T+3 (grey) and T+2 (black) standard settlement cycles*

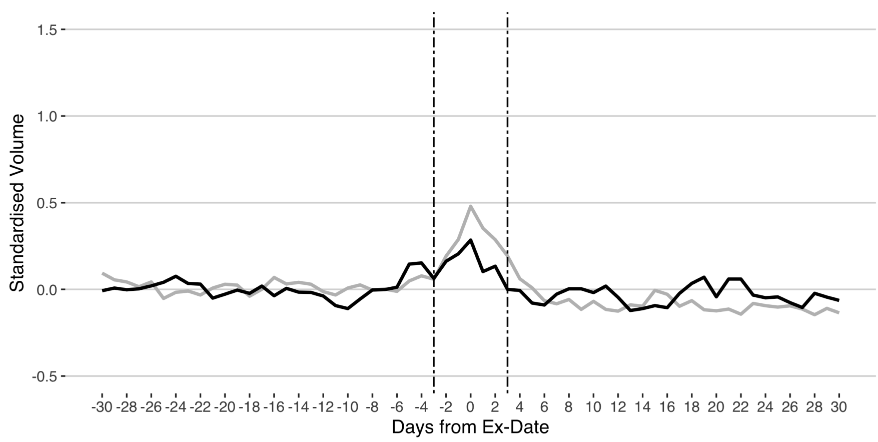

Figure A3.8: *France with T+3 (grey) and T+2 (black) standard settlement cycles*

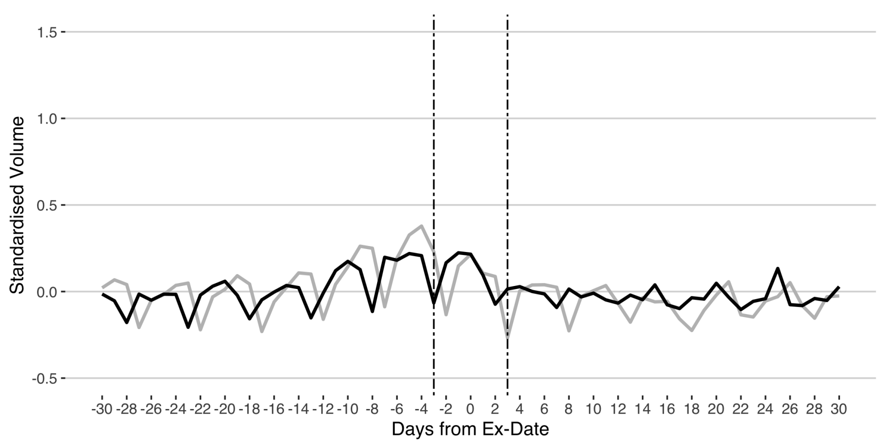

Figure A3.9: *The UK with T+3 (grey) and T+2 (black) standard settlement cycles*

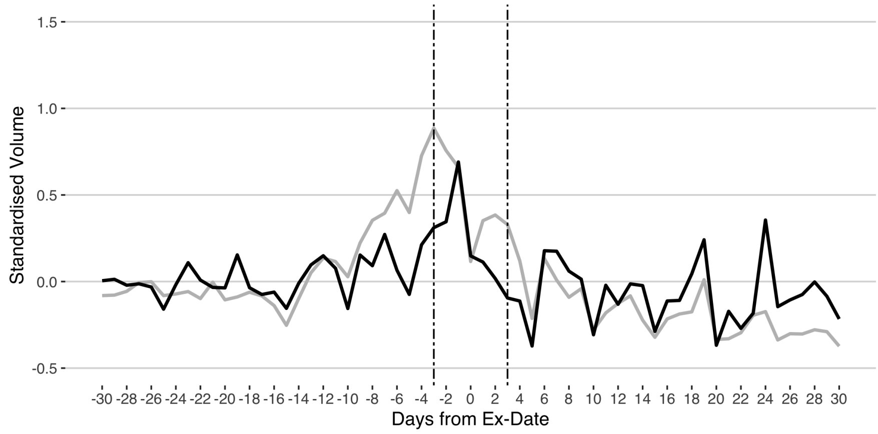

Figure A3.10: *Italy with T+3 (grey) and T+2 (black) standard settlement cycles*

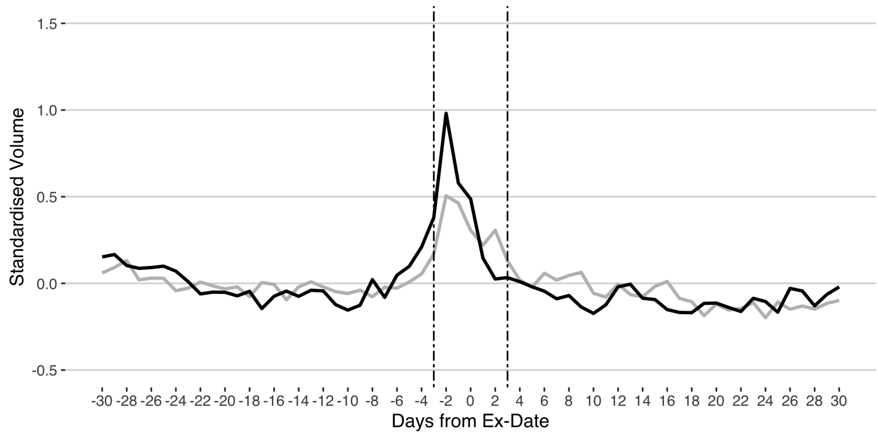

Figure A3.11: *The Netherlands with T+3 (grey) and T+2 (black) standard settlement cycles*

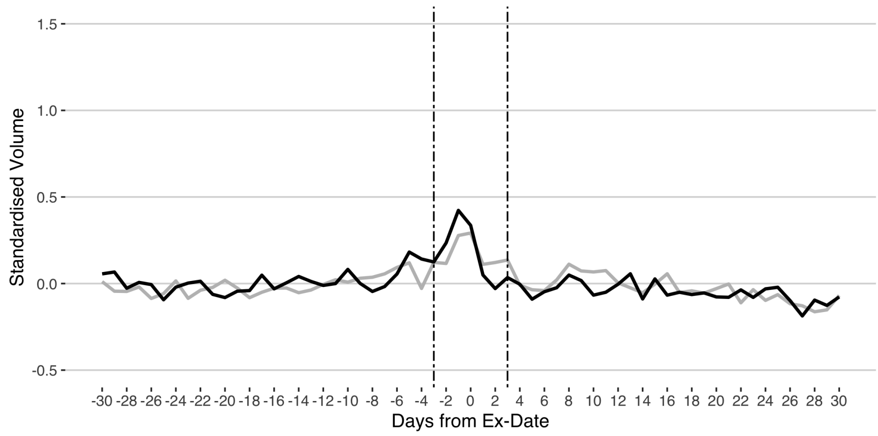

Figure A3.12: *Norway with T+3 (grey) and T+2 (black) standard settlement cycles*

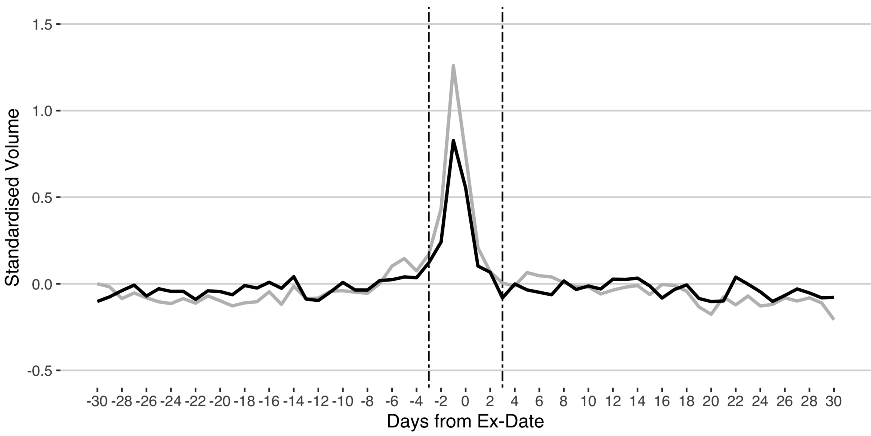

Figure A3.13: *Sweden with T+3 (grey) and T+2 (black) standard settlement cycles*

A4 Plots before and after legislative changes to combat DWT schemes

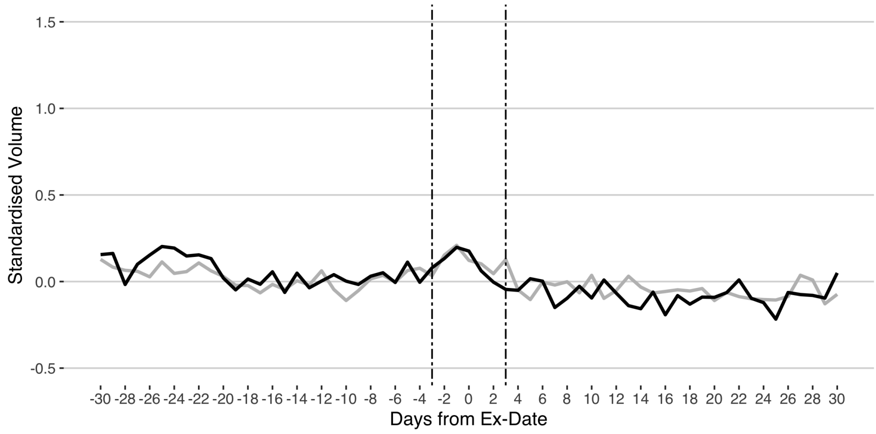

Figure A4.1: *Austria before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

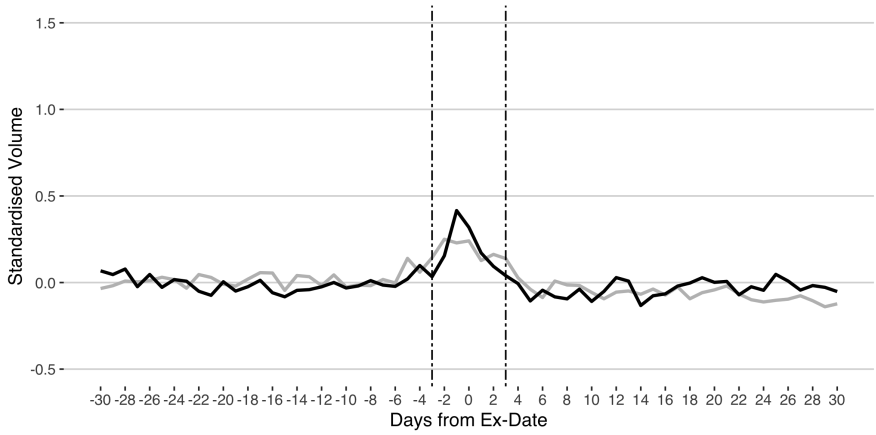

Figure A4.2: *Belgium before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

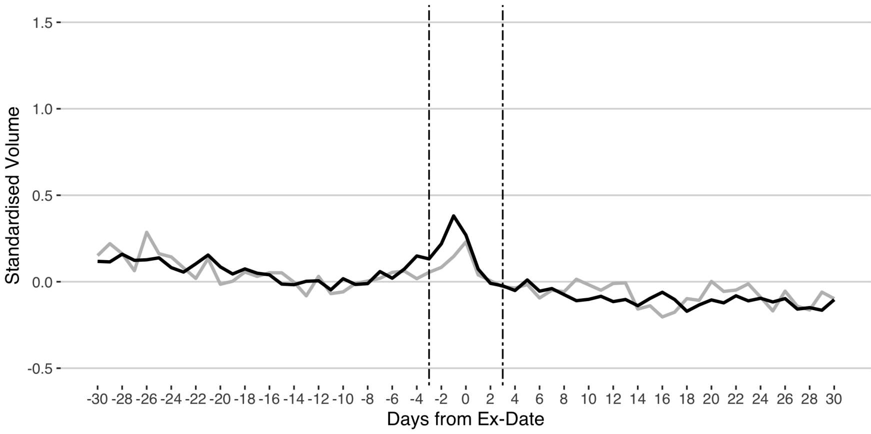

Figure A4.3: *Switzerland before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

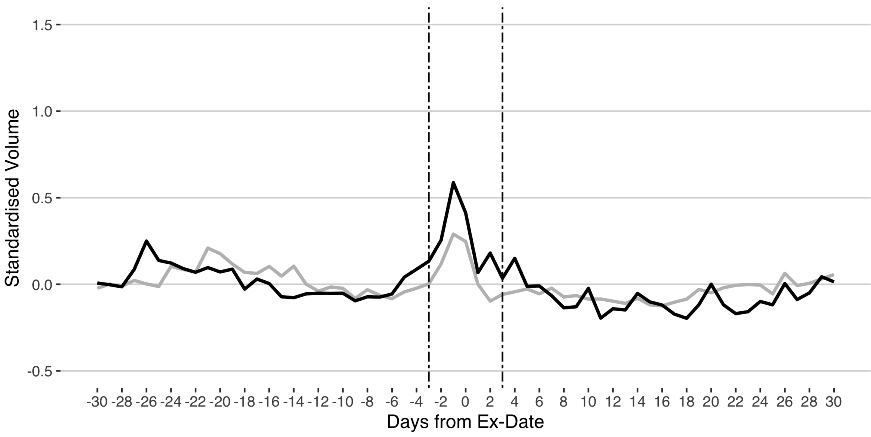

Figure A4.4: *Denmark before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

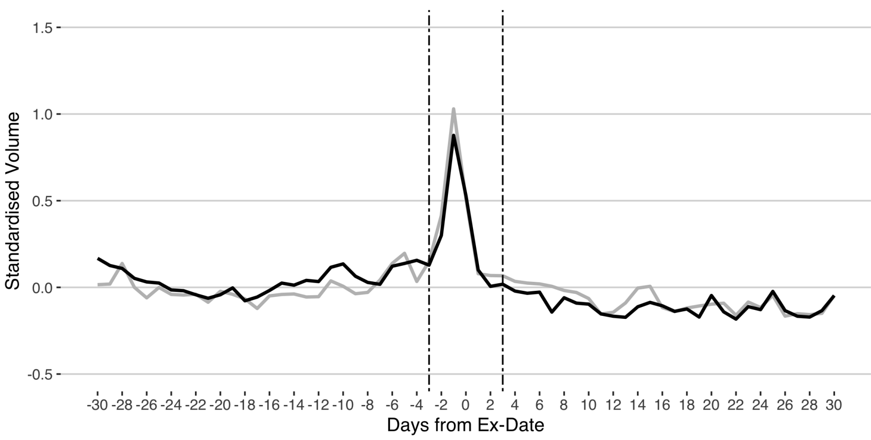

Figure A4.5: *Germany before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes in 2012*

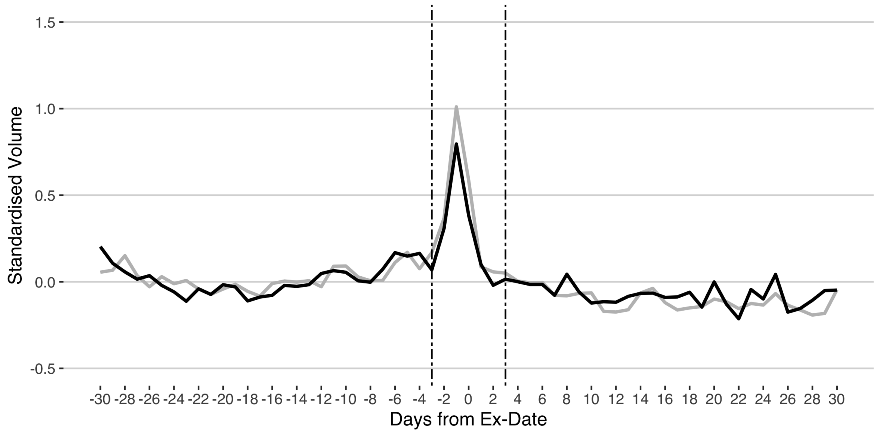

Figure A4.6: *Germany before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes in 2016*

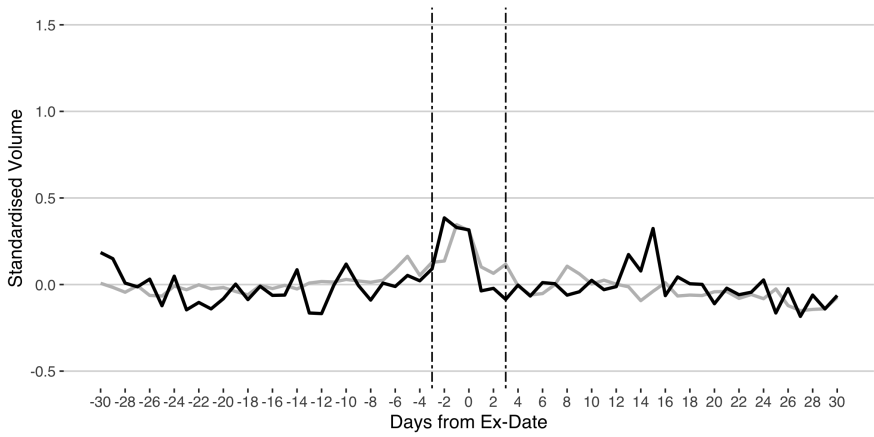

Figure A4.7: *Norway before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

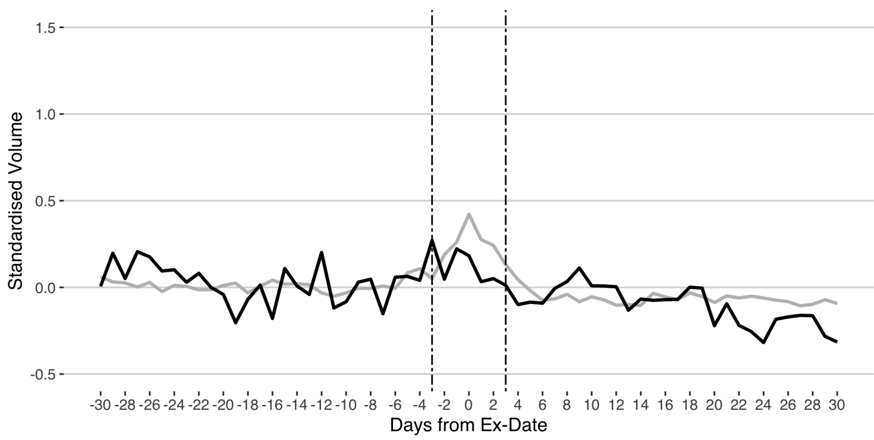

Figure A4.8: *France before (grey) and after (black) the implementation of legislative changes aimed at combating DWT schemes*

A5 Legislative Changes to Combat DWT schemes

Country	Date	Legislative / regulatory changes
Switzerland	01.01.2008	In 2008 Switzerland implemented adjustments to their legislation, particularly regarding the centralisation of collecting and reimbursement of DWT.
Germany	01.01.2012	Replacement of the debtor-principle. From this date the paying-agent principle is introduced. This means the issuance of tax certificates, and reception and transmission of the DWT is handled by the same institution.
Austria	01.01.2015	From this date, the applicants of tax reimbursements must submit their collective claims in a single application after the calendar year's expiration, and an intensifying of the obligation to provide evidence of entitlement to the DWT reclaim request.
Belgium	22.01.2015	Belgium implemented a new law directly aimed at combatting DWT-schemes: the "Law of 11 January 2019 on Combating Tax Fraud and Tax Avoidance regarding WHT". Under this new law all pension funds have to retain full ownership of their assets for an uninterrupted period of at least 60 days, otherwise the dividends received will be considered "artificial" regarding the tax legislations, and no reimbursement may be remitted. The DWT imposed on any dividend is to be used only to offset Belgian income tax, and only if the beneficiary of the dividend has held the shares for 60 days. The requirements for entitlement to income deriving from a Belgian DWT have also been made stricter.
Denmark	01.01.2016	New regulatory measures was implemented including five refund requirements that all have to be met to qualify for a tax refund from the Danish tax authorities. These five requirements will according to the authorities make DWT-schemes impossible to perform by using the methods we know today.
Germany	01.01.2016	Aimed at combating cum-cum schemes. The focus of the changes in 2016 is to make it harder to execute a cum-cum scheme in German markets. The change is related to how long an investor must hold the shares before and after the ex-date to be eligible for a tax refund.
Norway	01.01.2019	Norway has implemented a legislative change regarding the refunding procedure for DWT, imposing more requirements of documentation on the investors for DWT refunds. Norway has also increased market surveillance to discover potential DWT-schemes.
France	01.07.2019	The main implementation aimed at combating DWT-schemes is the requirement of proof of evidence from the beneficiary that the underlying transaction's main purpose is neither to avoid the application of a withholding tax, nor to obtain a tax benefit, hence a similar change to that of Belgium and Denmark where the investors must provide proof that the financial transaction had other economic motives than the refund of tax.
Finland	01.01.2021	The treaty in Finland happens outside the scope of this thesis. We have not included data after 2020. The changes in Finland is an enhancement of the transparency on dividend beneficiary information through the implementation of a new system (OECD Treaty Relief and Compliance Enhancement - TRACE- model) that reports to the Finnish Tax Administration information on the dividend beneficiary.

Table A5.1: *Summary of the country specific legislative changes aimed at combating DWT-schemes treated in this thesis.*

A6 Regressions Using Huber-White- Robust Standard Errors

Regression is specified as Model 4.4:

$$Y_{i,t} = \beta_1 + \beta_2 \lambda_i E_t + \beta_3 \lambda_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t + \beta_{5,j} C_j T_t^{-1} S_i^{T3}$$
$$+ \beta_{6,j} C_j E_t R_i + \beta_{7,j} C_j E_t R_i^* + \beta_{8,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$$

	(1)	(2)	(3)
Event window	$t \in (-3,-1)$	$t \in (-3,3)$	$t \in (-2,-1)$
Extended event window	$t = -4$	$t = -4$	$t = -3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\lambda_i E_t$	0.572***	0.236**	0.770***
	(0.175)	(0.0958)	(0.238)
$\lambda_i T_t^{-1} S_i^{T3}$	-0.00378	-0.00378	0.162
	(0.115)	(0.115)	(0.292)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.008	0.010	0.008
Country FE	YES	YES	YES
Reform FE	YES	YES	YES
Robust SE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.1: *Regression results from extensive margin response model.*

Regression is specified as Model 4.6: $Y_{i,t} = \beta_1 + \beta_2\lambda_i E_t + \beta_3\lambda_i T_t^{-1} S_i^{T3}$ $+\beta_{4,j} C_j E_t R_i + \beta_{5,j} C_j E_t R_i^* + \beta_{6,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$			
	(4)	(5)	(6)
Event window	$t \in (-3,-1)$	$t \in (-3,3)$	$t \in (-2,-1)$
Extended event window	$t=-4$	$t=-4$	$t=-3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\lambda_i E_t$	0.390***	0.307***	0.457***
	(0.00647)	(0.00399)	(0.00813)
$\lambda_i T_t^{-1} S_i^{T3}$	0.240***	0.253***	0.250***
	(0.0125)	(0.0125)	(0.0128)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.006	0.008	0.006
Country FE	NO	NO	NO
Reform FE	YES	YES	YES
Robust SE	YES	YES	YES
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

Table A6.2: *Regression results from Extensive tax model, not including country specific fixed effects*

Regression is specified as Model 4.5: $Y_{i,t} = \beta_1 + \beta_2\tau_i E_t + \beta_3\tau_i T_t^{-1} S_i^{T3} + \beta_{4,j} C_j E_t + \beta_{5,j} C_j T_t^{-1} S_i^{T3}$ $+\beta_{6,j} C_j E_t R_i + \beta_{7,j} C_j E_t R_i^* + \beta_{8,j} C_j T_t^{-1} S_i^{T3} R_i + \varepsilon_{i,t}$			
	(7)	(8)	(9)
Event window	$t \in [-3,-1]$	$t \in [-3,3]$	$t \in [-2,-1]$
Extended event window	$t=-4$	$t=-4$	$t=-3$
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES			
$\tau_i E_t$	-0.00802***	0.00168	-0.00804**
	(0.00303)	(0.00174)	(0.00400)
$\tau_i T_t^{-1} S_i^{T3}$	-0.00513	-0.00513	-0.00937*
	(0.00467)	(0.00467)	(0.00513)
Observations	1,176,141	1,176,141	1,176,141
R-squared	0.008	0.010	0.008
Country FE	YES	YES	YES
Reform FE	YES	YES	YES
Robust SE	YES	YES	YES
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1			

Table A6.3: *Regression results from intensive margin response model*

Regression is specified as Model 4.7: $Y_{i,t} = \beta_1 + \beta_{2,j}T_t^{-1}S_i^{T3}C_j + \beta_{3,j}E_tC_j + \beta_{4,j}R_iE_tC_j + \beta_{6,j}R_i^*E_tC_j + \beta_{7,j}R_iT_t^{-1}S_i^{T3} + \beta_{8,d,j}W_dC_j + \varepsilon_{i,t}$		
	(10)	(11)
Event Window	$t \in [-2,-1]$	$t \in [-2,-1]$
Extended Event Window	$t=-3$	$t=-3$
Years Included	2004-2020	2013-2016
Estimation Method	Pooled OLS	Pooled OLS
VARIABLES		
$T_t^{-1}S_i^{T3} * AUT$	**0.0412**	0.0107
	(0.0461)	(0.102)
$T_t^{-1}S_i^{T3} * BEL$	0.151***	0.0947
	(0.0366)	(0.0945)
$T_t^{-1}S_i^{T3} * CHE$	0.0554	0.225***
	(0.0620)	(0.0693)
$T_t^{-1}S_i^{T3} * DNK$	**0.0133**	-0.0349
	(0.0381)	(0.0864)
$T_t^{-1}S_i^{T3} * ESP$	**0.384*** **	0.106**
	(0.0349)	(0.0508)
$T_t^{-1}S_i^{T3} * EST$	0.387*	0.283
	(0.229)	(0.291)
$T_t^{-1}S_i^{T3} * FIN$	0.145***	0.0994
	(0.0351)	(0.0770)
$T_t^{-1}S_i^{T3} * FRA$	0.0782***	0.00716
	(0.0299)	(0.0552)
$T_t^{-1}S_i^{T3} * GBR$	0.159***	0.110*
	(0.0238)	(0.0595)
$T_t^{-1}S_i^{T3} * ITA$	**0.888*** **	**0.663*** **
	(0.0529)	(0.113)
$T_t^{-1}S_i^{T3} * NLD$	0.183***	0.175*
	(0.0364)	(0.0902)
$T_t^{-1}S_i^{T3} * NOR$	0.134***	0.0963
	(0.0487)	(0.0949)
$T_t^{-1}S_i^{T3} * SWE$	0.210***	0.0464
	(0.0363)	(0.0622)
Observations	1,176,141	283,905
R-squared	0.018	0.018
Country FE	YES	YES
Reform FE	YES	YES
Weekday FE	YES	YES
Robust SE	YES	YES
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Table A6.4: *Regression results for the effect of settlement cycle model. In bold: Coefficients that are statistically different from the United Kingdom at a 5 % significance level.*

Regression specified as Model 4.8: $Y_{i,t} = \beta_1 + \beta_2 E_t + \beta_3 R_i E_t + \varepsilon_{i,t}$						
	(12)	(13)	(14)	(15)	(16)	(17)
Event window	$t \in [-3, 3]$	$t \in [-2, -1])$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$
Country	AUT	AUT	BEL	BEL	DNK	DNK
Reform Year	2015	2015	2019	2019	2016	2016
Years inclunded	2012- 2017	2012- 2017	2017-2020	2017-2020	2013- 2018	2013-2018
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.0951*	-0.203**	-0.237***	-0.352***	0.0383	0.0973
	(0.0474)	(0.0885)	(0.0505)	(0.105)	(0.0440)	(0.0945)
Observations	13,925	13,925	19,046	19,046	21,198	21,198
R-squared	0.001	0.001	0.008	0.005	0.004	0.004
Robust SE	YES	YES	YES	YES	YES	YES
	(18)	(19)	(20)	(21)	(22)	(23)
Event window	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-3, 3]$
Country	FRA	FRA	CHE	CHE	NOR	NOR
Reform Year	2019	2019	2008	2008	2019	2019
Years inclunded	2018- 2020	2018- 2020	2005- 2010	2005- 2010	2017- 2020	2017- 2020
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.0851*	-0.231**	0.0706**	0.0677	-0.0635	-0.0333
	(0.0503)	(0.0993)	(0.0351)	(0.0636)	(0.0445)	(0.0904)
Observations	15,392	15,392	28,193	28,193	18,512	18,512
R-squared	0.004	0.003	0.002	0.001	0.004	0.005
Robust SE	YES	YES	YES	YES	YES	YES
	(24)	(25)	(26)	(27)	(28)	(29)
Event window	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$	$t \in [-3, 3]$	$t \in [-2, -1]$
Country	EST	EST	DEU	DEU	DEU	DEU
Reform Year	2010	2010	2012	2012	2016	2016
Years inclunded	2007- 2012	2007- 2012	2009- 2014	2009- 2014	2013- 2018	2013- 2018
Estimation Method	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
VARIABLES						
$R_i E_t$	-0.449***	-0.658*	-0.151***	-0.417***	-0.0893**	-0.0193
	(0.154)	(0.354)	(0.0396)	(0.0959)	(0.0343)	(0.0737)
Observations	2,867	2,867	30,975	30,975	33,947	33,947
R-squared	0.023	0.025	0.022	0.026	0.012	0.013
Robust SE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6.5: *Regression results of the reform model.*

A7 Test for heteroskedasticity

Regression (1)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 11975.83
         Prob > chi2  =   0.0000
```

Regression (2)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 11347.28
         Prob > chi2  =   0.0000
```

Regression (3)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 10696.18
         Prob > chi2  =   0.0000
```

Regression (4)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 8704.16
         Prob > chi2  =   0.0000
```

Regression (5)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 8507.61
         Prob > chi2  =   0.0000
```

Regression (6)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 8024.84
         Prob > chi2  =   0.0000
```

Regression (7)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 11572.94
         Prob > chi2  =   0.0000
```

Regression (8)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 11259.64
         Prob > chi2  =   0.0000
```

Regression (9)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 10277.49
         Prob > chi2  =   0.0000
```

Regression (10)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 17990.78
         Prob > chi2  =   0.0000
```

Regression (11)

```
\textbf{Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      = 17990.78
         Prob > chi2  =   0.0000}
```

Regression (12)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     1.25
         Prob > chi2  =   0.2626
```

Regression (13)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     0.36
         Prob > chi2  =   0.5508
```

Regression (14)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   283.76
         Prob > chi2  =   0.0000
```

Regression (15)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   270.80
         Prob > chi2  =   0.0000
```

Regression (16)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =    43.90
         Prob > chi2  =   0.0000
```

Regression (17)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   123.04
         Prob > chi2  =   0.0000
```

Regression (18)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     0.30
         Prob > chi2  =   0.5862
```

Regression (19)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =    27.15
         Prob > chi2  =   0.0000
```

Regression (20)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     0.34
         Prob > chi2  =   0.5624
```

Regression (21)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     0.58
         Prob > chi2  =   0.4460
```

Regression (22)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =     5.60
         Prob > chi2  =   0.0179
```

Regression (23)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =    23.97
         Prob > chi2  =   0.0000
```

Regression (24)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   589.26
         Prob > chi2  =   0.0000
```

Regression (25)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   716.23
         Prob > chi2  =   0.0000
```

Regression (26)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   409.19
         Prob > chi2  =   0.0000
```

Regression (27)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =  1157.53
         Prob > chi2  =   0.0000
```

Regression (28)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =    72.86
         Prob > chi2  =   0.0000
```

Regression (29)

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of volume

         chi2(1)      =   178.06
         Prob > chi2  =   0.0000
```

A8 VIF Test for Multicollinearity

As we are not interested in determining the significance of the coefficients for our control variables we have only included the results for our variables of interest and the mean VIF in these tables.

	(1)		(2)		(3)	
VARIABLES	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$
$\lambda_i E_t$	433.14	0.002309	408.65	0.002447	439.26	0.002277
$\lambda_i T_t^{-1} S_i^{T3}$	452.53	0.002210	452.53	0.002210	452.48	0.002210
Mean VIF	48.47		47.77		48.65	

Table A8.1: *Results of VIF test for the intensive margin response models*

	(4)		(5)		(6)	
VARIABLES	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$
$\lambda_i E_t$	1.22	0.819174	1.21	0.827183	1.22	0.817115
$\lambda_i T_t^{-1} S_i^{T3}$	1.06	0.941104	1.06	0.940659	1.06	0.941202
Mean VIF	1.05		1.05		1.05	

Table A8.2: *Results of VIF test for the intensive margin response models, without country specific effects*

	(7)		(8)		(9)	
VARIABLES	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$
$\tau_i E_t$	120.64	0.008289	114.11	0.008764	122.30	0.008177
$\tau_i T_t^{-1} S_i^{T3}$	110.38	0.009059	110.38	0.009059	110.36	0.009061
Mean VIF	13.61		13.43		13.66	

Table A8.3: *Results of VIF test for the extensive margin response models*

	(10)		(11)	
VARIABLES	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$
$T_t^{-1} S_i^{T3} * AUT$	1.01	0.988338	1.01	0.991524
$T_t^{-1} S_i^{T3} * BEL$	1.01	0.989954	1.01	0.992885
$T_t^{-1} S_i^{T3} * CHE$	2.83	0.353183	1.01	0.991599
$T_t^{-1} S_i^{T3} * DNK$	1.01	0.988653	1.01	0.991798
$T_t^{-1} S_i^{T3} * ESP$	1.01	0.987959	1.01	0.985325
$T_t^{-1} S_i^{T3} * EST$	1.76	0.568177	1.01	0.989541
$T_t^{-1} S_i^{T3} * FIN$	1.01	0.988721	1.01	0.990495
$T_t^{-1} S_i^{T3} * FRA$	1.01	0.989841	1.01	0.992335
$T_t^{-1} S_i^{T3} * GBR$	1.04	0.959656	1.03	0.973062
$T_t^{-1} S_i^{T3} * ITA$	1.05	0.948998	1.03	0.968450
$T_t^{-1} S_i^{T3} * NLD$	1.01	0.988646	1.01	0.991376
$T_t^{-1} S_i^{T3} * NOR$	1.01	0.990647	1.01	0.992201
$T_t^{-1} S_i^{T3} * SWE$	1.01	0.990162	1.01	0.993037
Mean VIF	2.65		2.64	

Table A8.4: *Results of VIF test for the settlement change models*

	(12)		(13)		(14)		(15)		(16)		(17)	
VARIABLES	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$	**VIF**	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$
$R_i E_t$	1.93	0.517265	2.02	2.02	1.76	0.568593	1.83	0.546922	2.14	0.468188	2.24	0.446250
Mean VIF	1.93		2.02		1.76		1.83		2.14		2.24	
	(18)		(19)		(20)		(21)		(22)		(23)	
VARIABLES	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$
$R_i E_t$	1.38	0.724876	1.41	0.710061	1.86	0.539039	1.93	0.516983	1.84	0.544661	1.92	0.522174
Mean VIF	1.38		1.41		1.86		1.93		1.84		1.92	
	(24)		(25)		(26)		(27)		(28)		(29)	
VARIABLES	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$	VIF	$\frac{1}{VIF}$
$R_i E_t$	1.55	0.645385	1.60	0.624868	2.00	0.500924	2.09	0.478788	1.89	0.529569	1.97	0.507443
Mean VIF	1.55		1.60		2.00		2.09		1.89		1.97	

Table A8.5: *Results of VIF test for the reform models*

A9 Shapiro-Wilk W Test for Normality

Regression (1)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80461    2.3e+04    28.498    0.00000
```

Regression (2)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80439    2.3e+04    28.501    0.00000
```

Regression (3)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80432    2.3e+04    28.502    0.00000
```

Regression (4)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80358    2.3e+04    28.513    0.00000
```

Regression (5)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80333    2.3e+04    28.516    0.00000
```

Regression (6)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80357    2.3e+04    28.513    0.00000
```

Regression (7)

```
                   Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+------------------------------------------------------
       resid |  1,176,141    0.80456    2.3e+04    28.498    0.00000
```

Regression (8)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	1,176,141	0.80437	2.3e+04	28.501	0.00000

Regression (9)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	1,176,141	0.80426	2.3e+04	28.503	0.00000

Regression (10)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	1,176,141	0.80436	2.3e+04	28.501	0.00000

Regression (11)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	283,905	0.80643	1.1e+04	26.463	0.00000

Regression (12)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	13,925	0.78808	1400.418	19.561	0.00000

Regression (13)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	13,925	0.78848	1397.744	19.556	0.00000

Regression (14)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	19,046	0.78145	1877.142	20.505	0.00000

Regression (15)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	19,046	0.78131	1878.279	20.506	0.00000

Regression (16)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	21,198	0.73980	2441.057	21.271	0.00000

Regression (17)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	21,198	0.74117	2428.169	21.256	0.00000

Regression (18)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	15,392	0.85717	1027.040	18.770	0.00000

Regression (19)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	15,392	0.85853	1017.284	18.744	0.00000

Regression (20)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	28,193	0.83622	1936.445	20.766	0.00000

Regression (21)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	28,193	0.83632	1935.284	20.764	0.00000

Regression (22)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	18,512	0.74355	2151.360	20.862	0.00000

Regression (23)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	18,512	0.74419	2145.995	20.855	0.00000

Regression (24)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	2,867	0.56966	707.585	16.907	0.00000

Regression (25)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	2,867	0.56401	716.869	16.940	0.00000

Regression (26)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	30,975	0.83442	2110.452	21.042	0.00000

Regression (27)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	30,975	0.84175	2016.984	20.918	0.00000

Regression (28)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	33,947	0.82492	2399.242	21.433	0.00000

Regression (29)

Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
resid	33,947	0.82686	2372.611	21.403	0.00000