Welfare Effect of Closing Loopholes in the Dividend-Withholding Tax: The Case of Cum-cum and Cum-ex Transactions *

Elisa Casi[1, 2, 3], Evelina Gavrilova[1, 2], David Murphy[1, 2] , and Floris Zoutman[1, 2, 4]

[1]Norwegian School of Economics (NHH): Department of Business and Management Science
[2]Norwegian Center for Taxation (NoCeT)
[3]ZEW Mannheim
[4]CESifo

February 18, 2022

Abstract

We study the effect of reforms that close loopholes in the enforcement of the dividend-withholding tax (DWT). We focus on a Danish reform enacted in 2016, and compare Denmark to its Nordic neighbors. Our main outcome of interest is the quantity of stocks on loan. Before the reform all Nordic countries have a strong spike in stocks on loan centered around the ex-dividend day. The magnitude is large: on average excess stocks on loan peak at around 4 percent of the public float. The spike in lending is consistent with the most popular DWT arbitrage schemes. After the reform the spikes in Denmark disappear, but they continue in the other Nordics. We interpret this as evidence that the reform was successful at eliminating DWT arbitrage. We consider the welfare effects of the reform. Using synthetic difference-in-difference we find that stricter DWT enforcement resulted in a 130 percent (approx. 1.3 bln USD annually) increase in DWT revenue in Denmark. We detect no changes in foreign portfolio investment or dividend policy. We also consider DWT arbitrage among 15 European countries between 2010-2019. We find evidence of DWT arbitrage in all countries that levy DWT, though there is strong heterogeneity across countries. Importantly, similar to Denmark, Germany's 2016 reform has eliminated the spikes in lending completely. We validate our identification strategy by showing that we find no evidence of DWT arbitrage in the UK, which does not levy a DWT.

*We would like to thank David Agrawal, Giacomo Benini, Thiess Buettner, Trond Døskeland, Ana Jorge Finnigan, Irem Guceri, Niels Johannesen, Steffen Juranek, David Olav Kyte, Etienne Lehmann, Arjan Lejour, Pete Lisowsky, Jarle Møen, Kit Merete Midttun, Andreas Peichl, Juan Carlos Suarez Serrato, Sebastian Siegloch, Laurent Simula, Simone Traini, Guttorm Schjelderup, Christoph Spengel, Maximillian Todtenhaupt and Eric Zwick for helpful comments and suggestions. We are thankful to the Norwegian Tax Authorities, Statistics Denmark, Finnish Tax Authorities and Statistics Sweden and Swedish Tax Authorities for the access to the tax revenue data on DWT. In addition, we are grateful to the Research Council of Norway for funding under grant number 300955. Elisa Casi gratefully acknowledges financial support from the German Research Foundation Project-ID 403041268 – TRR 266 Accounting for Transparency.

JEL classification: H25, H26, O16, F38

Keywords: Dividend Tax Arbitrage, Tax Enforcement, Financial Innovation, Welfare Analysis

1 Introduction

It is well known, that financial development and innovation contribute to economic growth.[1] However, in the wake of the financial crisis, a large literature has developed showing that financial innovation also has negative economic consequences; for instance, by contributing to financial fragility and opacity.[2] There is another negative aspect that has received little attention. Financial innovation is particularly well-suited to exploit tax loopholes, thereby eroding the tax base. The financial toolbox is highly flexible, and innovation typically outpaces the response of regulators (Zingales, 2015). Therefore, it is profitable for financial players to develop transactions that exploit vulnerabilities in the tax code.

We contribute by studying two such transactions that exploit loopholes in the administration of dividend-withholding tax (DWT), *and* by evaluating the welfare effects of the subsequent response by regulators. The first transaction, known as cum-cum, allows foreign investors to avoid DWT payments. The second transaction, known as cum-ex, allows investors to receive DWT reimbursement twice for a single DWT payment.[3] Researchers at the University of Mannheim estimate that the two schemes jointly resulted in a tax revenue loss of 150 billion euro in the period 2000-2020 (Spengel, 2021a,b; Spengel et al., 2017). This constitutes, by far, the largest tax arbitrage scheme ever uncovered. The scale is captured in the quote by Christoph Spengel who called it *"The biggest tax robbery in European history"* when invited as an expert witness at the EU parliament hearing in January 2021.[4]

[1] See e.g. Levine, 2005.

[2] For instance, Keys et al. (2010, 2012) find evidence that mortgage securitization during the financial crisis increases the probability of default. Henderson and Pearson (2011) show that retail structured products are systematically overpriced, exploiting uninformed investors, while Sato (2014) shows that opaque assets command a price premium, which incentivises financial engineers to render more products opaque. Pérignon and Vallée (2017) show that local French politicians use structured loans to time repayments after, rather than before reelection. In a recent literature overview Griffin (2021) concludes that fraud related to structured financial products has been a major contributor to the financial crisis.

[3] It is unclear when cum-cum and cum-ex transactions became popular but evidence suggests that cum-cum and cum-ex transactions have been popular since the 1990s, see Dutt, V., and Spengel, C., and Vay, H. (2018))

[4] Both cum-cum and cum-ex have been ruled as fraudulent transactions according to, for example, court cases in January 2020 at the Hesse Tax Court on cum-cum transactions and in March 2020 by the regional court of Bonn on cum-ex transactions (Spengel, 2021c). However, the legality has not been decided universally

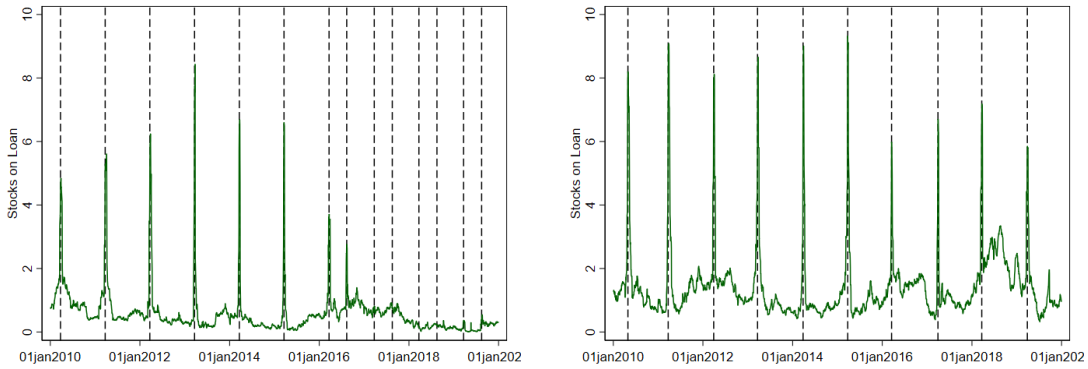
Our study makes use of the fact that most cum-cum and cum-ex transactions rely on the security-lending market. In a cum-cum transaction, a foreign investor enters into an agreement with a domestic bank to lend its shares shortly before the dividend record date. Given the different tax treatment of domestic versus foreign investors, this allows the foreign investor to benefit from DWT reimbursement. In a cum-ex transaction, shares are sold short before the dividend record date but delivered after the dividend record date. Such transactions can trigger a tax reimbursement twice even though the tax is effectively paid only once. Because both transactions make use of stock lending, the number of stocks on loan spike sharply around ex-dividend dates. These spikes are clearly visible even in raw data (see e.g. Figure 1).

Cum-cum and cum-ex are most prevalent in Europe. According to CORRECTIV (2021) 94 percent of tax revenue losses occur in Europe. We therefore collect security-lending data for 15 European countries that harbor Europe's largest financial markets. A number of countries in our sample have recently attempted to close the loopholes exploited by investors. However, to our knowledge the effect of these reforms has not been evaluated. In this paper we address this issue, and study the welfare effects of the reforms.

Our analysis consists of three parts. First, we consider the effect of the countermeasures on cum-cum and cum-ex transactions, as observed by the spikes in the security-lending market. Second, we explore the broader welfare implications of the countermeasures by studying tax revenue, foreign portfolio investment (FPI), and dividend policy. Third, we document the extent to which cum-cum and cum-ex have affected financial markets in 15 Western-European economies.

In the first two parts we focus on the Nordic countries: Denmark, Finland, Norway and Sweden. The Nordics provide an ideal laboratory for our study for two reasons. First, the four countries are similar in cultural background, regulatory framework and other socioeconomic characteristics, thus forming a natural control group for one another. In 2016 Denmark introduced a reform that targets cum-cum and cum-ex, but leaves non-tax related arbitrage transactions unaffected, allowing us to separately identify tax arbitrage from non-tax arbitrage. Second, through close cooperation with the tax authorities in the four respective countries we have obtained detailed DWT revenue data that includes both annual tax receipts and

which is why we from here on refer to cum-cum and cum-ex as tax arbitrage rather than tax fraud.



a. Novo Nordisk b. Svenska Handelsbanken

Figure 1: Stocks on loan vs ex-dividend dates over time

Notes: The vertical axis denotes the stocks on loan as a share of the public float. The dashed lines represent ex-dividend dates. The Danish reform came into effect on 18th March 2016 and affected stocks of Novo Nordisk.

reimbursements. The DWT is, effectively, a tax on foreign investors (domestic investors are reimbursed for DWT, and instead pay income tax on their dividends). Therefore, DWT revenue constitutes a transfer from foreign taxpayers to the government, which provides a first-order gain to domestic welfare. Hence, without information on DWT revenue it is impossible to quantify the welfare gain of the reform. To our knowledge DWT revenue data has never been analyzed by researchers.

Our identification strategy in the first part of our analysis can be characterized as a triple difference-in-difference event study. We compare the stocks on loan as a percentage of the public float between i.) regular trading days, and event days which lie in a 31-day window centered around the ex-dividend date, ii.) Denmark and the other three Nordic countries, and iii.) before and after the 2016 reform.

A raw-data example can be observed in Figure 1, which compares the stocks on loan over time for the Danish pharmaceutical company Novo Nordisk (panel A), and the Swedish bank Svenska Handelsbanken (panel B). Prior to the reform in mid-2016 both companies see abrupt spikes in stocks on loan around each dividend payment, constituting up to 8 percent of the public float. After the reform, the spikes for Novo Nordisk disappear, but they continue for Svenska Handelsbanken. We interpret this as clear causal evidence that the Danish reform is successful in targeting the most common forms of cum-cum and cum-ex.

Our formal analysis confirms that the pattern observed in Figure 1 is representative of all

Nordic firms. Before the reform, on average, around 4 percent of the public float of Danish companies was on loan in the dividend period. This spike disappears in Danish companies, but continues in Finnish, Norwegian and Swedish companies. To understand the magnitude, in the US, Dixon et al. (2021) find a spike in stock lending of 0.6 percent of the public float. The effect we find is about 6.5 time larger. This indicates that DWT arbitrage in Europe is much more prevalent than in the US, consistent with the findings of CORRECTIV (2021), and with the institutional setting which provides much stronger incentives for DWT arbitrage in Europe than in the US.[5]

Regarding heterogeneity, DWT arbitrage primarily targets the largest companies. Prior to the reform, spikes are consistently largest in the quartile of companies with the highest market capitalisation. This is likely driven by the fact that larger companies are more often included in the portfolio of foreign investors. We do not find a strong relationship between dividend yield and DWT arbitrage, which suggests that investors engage in DWT arbitrage even if the potential benefits are relatively small.

In the second part of our analysis, we consider the welfare effects of the reform. We first build a simple model in the spirit of Chetty (2009), but adapt it to a setting with international DWT. Our model contains three stakeholders: the government who collects DWT revenue, domestic companies that benefit from FPI, and foreign investors who pay DWT. We define domestic welfare as the weighted sum of tax revenue and the surplus of domestic companies. An enforcement shock to DWT affects welfare through the following channels. First, enforcement affects tax revenue, both mechanically by increasing the effective tax rate on foreign investors, and behaviorally by affecting the incentive for FPI and dividend payments. Second, changes in FPI and dividend policy affect the profitability of domestic companies. Therefore, to quantify the welfare effects of the reform we need to understand its causal impact on i.) tax revenue, ii.) FPI, and iii.) dividend policy.

We first consider the effect on tax revenue. Using Syntethic DiD (Arkhangelsky et al., 2021), we compare net DWT revenue in Denmark to a weighted average of Finland, Norway and Sweden. We find that annual tax revenue in Denmark increases by approximately 1.3 Billion USD. This number represents 130 percent of the net DWT revenue Denmark obtained

[5]We present more details on the institutional settings in section 2.

in 2014. Descriptive statistics indicate that the increase in DWT revenue was mostly the result of a reduction in reimbursements, consistent with the purpose of the reform.

Using the same methodology, we estimate the effect of the reform on FPI. Using bilateral data from the IMF on US equity investments into the Nordics, we find no significant reduction in Danish FPI relative to synthetic Denmark. Third, we consider whether the reform has affected dividend yield in Danish companies. Using a company-level event study and controlling for industry-time effects we find no evidence that dividend yield (intensive margin) or dividend distributions (extensive margin) are affected by the reform. This indicates that stricter DWT enforcement in Denmark leads to higher tax revenue without affecting FPI or dividend policy. Hence, according to our model the reform constitutes a domestic welfare gain of 1.3 billion USD annually in Denmark.

In the final part of our analysis, we focus on security-lending data from the other European countries. We find that the spike in security lending around dividend payment is ubiquitous across European countries that levy a DWT. However, there is also strong heterogeneity. Germany has the most excess lending in the dividend period, reaching up to 10 percent of the public float. On the other hand, effects in Southern Europe and Ireland are more muted. Importantly, the effect of the 2016-reform in Germany aimed at reducing DWT arbitrage was successful. After this reform, the spikes in Germany disappear entirely. Similarly, the spikes in Austria disappear after a reform in 2018.

In the Online Appendix we consider two additional case studies in more detail: Germany and the UK. We use the German case study to create an upper-bound of the importance of cum-ex relative to cum-cum transactions. We exploit the fact that Germany has two reforms: a 2012 reform that targets cum-ex, and a 2016-reform that targets cum-cum. We find that in Germany, prior to 2012, at most 12 percent of the transactions relate to cum-ex. Further, we provide evidence to suggest that cum-ex has been more pronounced in Germany than in other countries. Hence, from a tax-revenue perspective cum-cum is likely vastly more important than cum-ex.

We use the UK case study to validate our main identification strategy. The UK does not levy a DWT and as a result, we should not observe DWT arbitrage in the UK. We confirm this in the Online Appendix.

In addition, in the Online Appendix we address the concern that spikes in lending around the ex-dividend date may relate to non-tax arbitrage. When we control for the most popular form of non-tax arbitrage (see Ang et al., 2019) we find no meaningful impact on our main result for the Nordic countries.

Overall, our paper finds that DWT arbitrage in the form of cum-cum and cum-ex is a widespread phenomenon within Western Europe. The introduction of reforms in DWT enforcement, like the ones introduced in Denmark and Germany, appear to eliminate arbitrage entirely. In Denmark, we see that this results in a strong increase in tax revenue, and welfare.

Related Literature The most closely related paper is Buettner et al. (2019). They study the effect of a German 2012 reform aimed at preventing cum-ex. The main finding is that the reform was effective at reducing the spike in turnover on the German stock exchange around the dividend payment period. Relative to this paper we make several contributions. First, the reform in Denmark targets both cum-cum and cum-ex, allowing us to provide a more complete picture of DWT arbitrage. Second, we use security-lending data rather than turnover as our outcome variable. We show that around the dividend payment period spikes in excess security-lending are much larger than spikes in turnover as a percentage of the public float. Thus security-lending data provides a more complete picture of DWT arbitrage. In the Online Appendix we show that this is also the case for Germany. Third, we assess the welfare effect of the reform and the overall welfare implications. Fourth, using data from multiple countries provides us with a counterfactual for the reform effect, which results in cleaner identification.

To our knowledge there are two papers in the literature that study tax arbitrage with security lending data: Christoffersen et al. (2005) for the UK and Canada, and Dixon et al. (2021) for the US. We contribute to this literature by studying the effect of a reform, which allows us to isolate DWT arbitrage from potential other forms of arbitrage.

Our paper also contributes to the vast literature investigating the effect of stricter enforcement rules on tax compliance (e.g. Fack and Landais (2010), Kleven et al. (2011), Kopczuk et al. (2016), Carrillo et al. (2017), Almunia and Lopez-Rodriguez (2018)). We contribute by offering evidence not only on the direct consequence of stricter enforcement on taxpayer compliance (as the literature did so far, see Slemrod (2019) for a summary) but also on the overall welfare effect of the reform.

Finally, our paper contributes to the literature that studies arbitrage mechanisms around dividend payments (e.g. Lakonishok and Vermaelen, 1986; Karpoff and Walkling, 1990; McDonald, 2001; Dhaliwal and Li, 2006; Akhmedov and Jakob, 2010; Hartzmark and Solomon, 2013; Henry and Koski, 2017). We contribute by quantifying the extent to which arbitrage around the ex-dividend date is driven by DWT vs non-tax arbitrage.

The rest of the paper is organized as follows. Section 2 provides institutional background on DWT, cum-cum, cum-ex and the countermeasures. Section 3 describes the data. Section 4 presents the financial-market analysis for the Nordics. Section 5 studies the welfare effects. Section 6 focuses on the other European countries. Section 7 concludes.

2 Institutional Setting

2.1 Dividend Withholding Tax Arbitrage

2.1.1 Dividend Withholding Tax

In several countries around the world, dividend payments from corporations give rise to tax liabilities within the source country via a withholding tax.[6] When a company distributes dividends, it withholds the DWT and it remits the tax directly to the respective tax authority of the home source country. Applying a DWT is typically justified by the necessity to ensure the collection of taxes on assets, which due to their mobile nature would otherwise easily escape taxation (Petkova, 2020).

DWT represents a salient cost for investors (e.g., Cooper and Kaplanis, 1994, Cooper and Kaplanis, 1986). For example, across EU member states and the United States, DWT rates can be as high as 30%, as is visible in Table 1 where we provide the overview for the Nordic countries.[7] The DWT weights particularly heavy on foreign investors, because they are also potentially taxed on their worldwide capital income at the applicable rate in their country of residence. Thus, to guarantee that cross-border investment is not discouraged, bilateral double tax agreements often grant a reduced rate on DWT at source and a full credit for the DWT in the residence country of the investor. However, there is a high compliance cost for

[6] For an overview, see Endres and Spengel (2015).

[7] For a complete overview of DWT rates around the world, see https://taxsummaries.pwc.com/quick-charts/withholding-tax-wht-rates.

claiming foreign tax credits (Jacob and Todtenhaupt, 2020) and not every country has signed a bilateral double tax agreement. Moreover, the reduced rate is typically granted upon evidence of double taxation, but not every investor is subject to taxation in their residence country. This is particularly relevant for US pension funds which are often exempt from taxation. This makes foreign DWT a final tax for US pension funds.

DWT arbitrage strategies have been designed to permit investors to remove such costs or even to exploit the system to turn such costs into excess returns from holding shares in foreign corporations. DWT arbitrage strategies consist in the transfer of shares around the dividend record date. Following such a transaction, the right to the dividend is separated from the underlying share. Depending on when the transfer of the ownership of the shares with a dividend entitlement occurs and when the delivery of the shares occurs, such a transaction is known as either a cum-cum or a cum-ex transaction. In a cum-cum transaction the objective is to avoid the DWT, while a cum-ex transaction obtains profits from the multiple refund of a tax only paid once (European Securities and Markets Authority, 2020). Below we describe cum-cum and cum-ex transactions in more detail.

Cum-Cum Transactions In a cum-cum transaction the owner transfers the shares with attached dividend rights just before the dividend record date to an acquirer. The acquirer is a resident in the same country as the corporation paying the dividend. Shortly after the dividend record date, the shares are returned to the original owner. The owner and acquirer exploit the different tax treatment for capital income of resident taxpayers subject to unlimited tax liability and non-resident taxpayers subject to limited tax liability.

Figure 2 illustrates how the above-described DWT arbitrage strategy can lead to the avoidance of the DWT.[8]. At time $t-1$, foreign investor A, who is the legal owner of a share in a corporation, lends that share to domestic bank B. At $t-1$, the share is entitled a dividend in the amount D, in this example worth EUR 1,000,000 and payable at time t. The country where the corporation and the bank are resident levies a DWT of value T, which equals 25%, or EUR 250,000. At t, the domestic bank B receives the dividend of the amount D-T, i.e. EUR 750,000. At the same time, the domestic bank B also receives a DWT certificate because in Europe, domestic investors are entitled to a reimbursement from the DWT while

[8]For a detailed explanation of cum-cum transactions, see Spengel (2016)

foreign investors are not. As agreed, the domestic bank B returns the share back to the foreign investor A. In this case, there is no capital loss from resale but there is a deduction of the security lending fee as a business expense. In many countries, the securities lending fee is not considered a taxable income, and in this way, the foreign investor A has a net gain equal to the tax-free dividend, D, which in the example equals EUR 1,000,000. This net gain is typically shared with the domestic bank B.[9]

In cum-cum transactions, the transfer of the share around the ex-dividend day is recorded in our data as a loan of the stock. The number of stocks on loan is the main variable of interest in our analysis.

Cum-Ex Transactions Cum-ex transactions involve a transfer of shares around the dividend record date where the sale of shares occurs with dividend rights, but the delivery of the shares occurs after the record date and thus without dividend rights. This is possible because there is a time lag (typically two days) between the delivery of the shares and the conclusion of the transaction. The example below will clarify the mechanism of this dividend arbitrage strategy.[10]

As visible in Figure 3, investor A owns a share in a corporation. The share is traded at price P and it is entitled a dividend in the amount D, in this example worth EUR 1,000,000 and payable at time t. At time $t-1$, investor B makes a short sale of a share in the corporation to investor C, at price P. Delivery of the agreed transfer takes place at $t+1$, two days after the agreement as is standard in the stock market. At t, investor A receives the dividend. The corporation pays a DWT of T, which equals 25%, or EUR 250,000. Investor A receives a DWT credit at t, as A is the legal owner of the share in the corporation and thus, liable for the DWT. On the same day, investor B borrows the share from investor A and delivers it to investor C. Since after the ex-dividend day, the share is worth P-D, investor B is required to compensate investor C for the net-of-tax dividend with the delivery, which in this example equals EUR 750,000. For this transaction, investor C receives a DWT credit, if tax authorities treat dividend compensation and actual dividends identically. Finally, investor C sells the shares back to investor A. Both investor C and A can request a tax refund for a DWT paid

[9]The predominant case of cum-cum transaction involves securities lending as can also be seen in our results below. However, the same mechanism could in principal also take the form of a selling/re-purchasing agreement.

[10]For a detailed explanation of cum-ex transactions, see Collier (2020).

only once. The short seller, investor B, makes a profit equal to the DWT, which in our example equals EUR 250,000. This profit is *de facto* financed by the tax authority, and is conditional on the issuance of a second tax certificate. Absence such condition, investor B would incur a loss by engaging in the above described cum-ex transaction as he/she would incur in costs related to setting up such a transaction.[11]

Similar to cum-cum, cum-ex transactions are reflected in the stocks on loan variable. The reason is that the short-seller is required to borrow the share for delivery to the buyer. However, the short-sales also show up in transaction volume. We use the additional spike in turnover to quantify the relative importance of cum-cum vs cum-ex in our German case study in the Online Appendix.

2.2 Danish Reform: Increasing Ownership Information as a Countermeasure

In recent years different EU countries legislated several reforms to curb DWT arbitrage strategies. In our main analysis, we focus on such a reform in Denmark, which became effective on March 17, 2016 and abolished the possibility to apply for a tax refund at source.[12] Instead, dividend income is distributed net of the DWT and a tax refund can be subsequently requested upon the submission of relevant documentation. This includes evidence of beneficial ownership of the shares. Only the beneficial owner can receive a tax refund. If the shares were involved in a share-lending agreement, then the lender (and only the lender) of the shares will be recognized as the beneficial owner. If the borrower can document that he/she has been holding the stocks for more than six months, then he/she becomes the beneficial owner for tax reimbursement purposes.

The legislation in Denmark differs from the anti-arbitrage legislation introduced in Germany in 2016 and in France and Belgium in 2019. In these countries investors can only receive DWT reimbursement if they hold the shares for a 45(or in the case of Belgium 60)-day window around the dividend payment.[13] This legislation should bring a halt to DWT arbitrage, but it

[11] This example describes the most common form of a cum-ex transaction. However, there are other types of cum-ex transactions that do not require a short-sale. See Wigan (2019) for some examples.

[12] See `https://www.ey.com/en_gl/tax-alerts/denmark-proposes-new-withholding-tax-regime-for-dividends`.

[13] Similar legislation is in place in Australia and the US.

also potentially increases the cost of non-tax arbitrage around the dividend day. This implies that when analyzing these reforms, there could be conflicting forces that can bias quantifying the effect of the reform. Alternatively, in Denmark for short-term loans, the lender of the stock remains eligible for reimbursement, and hence, potentially non-tax arbitrage can remain profitable in Denmark after the reform. We describe the the non-Nordic legislation in more detail in section 6.1

2.3 Lending Incentives in the US versus the Nordics

The incentive to engage in DWT arbitrage is much stronger in the Nordics (and in Europe in general) than in the US. Two important differences in the institutional setting between the Nordic countries and the US are: (1) the holding period which is present in the US, but absent in the Nordics; and (2) a different tax treatment of dividend and dividend compensation payments. Specifically, in the United States, the Jobs and Growth Tax Relief Reconciliation Act of 2003 introduced a reduced DWT rate of 15% for qualified dividends, i.e. those paid by US companies and held for at least 60 days.

The holding period alters the incentives for borrowing/lending to some extent. Specifically, in Europe foreign investors have a strong incentive to transfer their shares to domestic parties essentially overnight in order to benefit from DWT reimbursement. In the US, some foreign investors may still face this incentive to transfer shares overnight. However, the vast majority of US investors have a disincentive to lend. For these investors, lending a share over the record day effectively breaks the holding period.

Moreover, even if the dividend compensation payment and the dividend itself are nominally equivalent, they are subject to different tax treatments. Specifically, the dividend compensation payment is subject to the investors' marginal income tax rate, which could be up to 37%. To enjoy the reduced tax rate, domestic investors in the US might refrain from lending their shares over dividend record dates or recall outstanding loans. This leads to a crunch in lending shares around a dividend date.

Evidence of a temporary reduction in the supply of lendable shares has been documented in the literature (Thornock, 2013). Similarly, Dixon et al. (2021) find that during a dividend payment, the demand for borrowing increases, whereas at the same time the stocks available

for lending decrease. We do not expect to observe a similar crunch in the Nordics. The reason is that DWT legislation in the Nordics does not specify a holding period in order to qualify for a DWT reimbursement and there is no preferential tax treatment for dividend compared to dividend compensation payment. Therefore, we expect that the supply for lending remains constant during the dividend period, both before and after the reform in Denmark, whereas the demand for lending strongly increases. We explore this hypothesis in more detail in section 4.2.

3 Data

We collect two types of data. Financial market data with a daily frequency which we use for our primary analysis, and annual data which we use for our welfare analysis.

3.1 Financial Market Data

Our primary dataset comes from Markit which collects data on security lending and borrowing from over-the-counter (OTC) transactions. We combine Markit data with daily securities data from Compustat Global. Our panel extends from 2010-2019.

We merge the data of Compustat and Markit on the basis of the International Securities Identification Number (ISIN) and/or the Stock Exchange Daily Official List (SEDOL) code which are present in both data sources. In the event where we cannot match observations on either ISIN or SEDOL, we merge on the basis of the company name. This allows us to match 96% of the Markit data.

Our unit of analysis is the security. We drop companies that do not pay dividends throughout the sample period. In addition, we drop secondary listings in case a stock is listed on multiple stock exchanges. Note that we do keep secondary stocks in the event where a company issues two different types of stocks.

Table 2 provides summary statistics for the four Nordic countries, before and after the reform, and inside and outside of the event window. Our main outcome variable is stocks on loan as a percentage of the public float. In addition, we observe the i.) quantity of stocks

that are available for lending as a percentage of the public float[14], ii.) daily turnover on the stock exchange as a percentage of the public float, iii.) cost of borrowing which is determined by a Markit algorithm and ranges between 1 (regular cost of borrowing)-10 (very high cost of borrowing), and iv.) and v.) a Herfindahl Index for lender and borrower concentration respectively.

3.2 Data for Welfare Analysis

We also collect annual data on DWT revenue, FPI, and dividend yield, which form crucial inputs to our welfare analysis in section 5. More specifically, our DWT revenue data consists of i.) annual gross DWT receipts and ii.) reimbursements. We calculate net DWT revenue as the difference between these two numbers and convert the local currencies into USD to make them comparable. Note that these data are unique in the sense that, to our knowledge, no country has previously made data on gross DWT revenue, and reimbursements available to researchers.

Our data on tax revenue has one caveat. Like most government accounts, the data are collected on a cash-flow basis. As a result, we cannot exclude the possibility that part of reimbursements in a particular year correspond to gross DWT receipts of the previous year. This is particularly apparent in Finland and Norway which both see a spike in reimbursements in 2015 related to previous claims (see Figure A.4 in the Online Appendix). In our analysis we deal with this by i.) using net DWT revenue rather than reimbursements as our main outcome variable and ii.) for our estimate of the causal effect of the reform we average over multiple years which likely cancels out the short-term noise.

Our FPI data stems from the IMF Coordinated Portfolio Investment Survey (CPIS). The CPIS survey collects data at the bilateral level on holdings of portfolio investment securities. Our measure for FPI is the equity holdings of US fund managers in Denmark, Finland, Norway and Sweden.

Finally, to calculate dividend yield we take our daily data and collapse it to the annual level. Dividend yield is calculated as the total annual dividend divided by the mean stock

[14]The market for security lending is slack, since the number of shares available for lending typically exceeds the number of shares actually on loan.

price during the year. This approach allows us to combine data from companies that have an annual dividend, with companies that distribute dividends on a more frequent basis. Summary statistics for our annual data are reported in Table 2 panel B.

4 The Effect of the Danish Reform on DWT arbitrage

The first part of our analysis focuses on whether the Danish reform targeted against DWT arbitrage has been successful at reducing cum-cum and cum-ex transactions. Our methodology is an event-study, in which we treat the ex-dividend date of a stock as the event. We organize our data as a three-way panel where i denotes the stock, t denotes the calendar date and τ denotes event time. We consider a 31-day windows centered around the ex-dividend date and we keep observations from outside of the event window, which form the omitted category in our analysis.

We estimate the following equation for each country:

$$y_{it\tau} = \sum_{k=2010}^{2019} (\beta_{\tau k} + \eta_{ik}) I(t \in k) + \varepsilon_{it\tau}, \tag{1}$$

where $I(t \in k)$ is a dummy that takes value 1 if date t is in year k. Our coefficient of interest is $\beta_{\tau k}$ which measures the excess stocks on loan on event day τ in year k. In the presence of DWT arbitrage schemes, we expect that $\beta_{\tau k} > 0$ for event dates τ close to the ex-dividend date, and in years prior to the reform.

η_{ik} represents security-year fixed effects which are identified by stocks on loan outside of the event window. η_{ik} controls for the regular amount of lending a stock would typically have in year k. We estimate equation (1) using weighted least squares, where the market value of the security serve as weights. Effectively, this weighting implies that our results can be interpreted as the average excess lending, as a percentage of the public float, per dollar of market value traded on the stock exchange. We cluster standard errors at the issuing company level.

4.1 Main Results

Figure 4 provides results for Denmark (panel A), Finland (Panel B), Norway (panel C) and Sweden (Panel D). Figure 4 plots all coefficients $\beta_{\tau k}$ of the event-study over the 10 years in our sample. The figure provides clear evidence of a spike in the number of stocks on loan around the ex-dividend day. Loans typically peak on day 1 or 2. The reason is that during the beginning of our sample period (2010-2014) the dividend-record date occurred 2 days after the ex-dividend date. For the remainder of the sample, the record date occurs 1 day after the ex-dividend date. Hence, lending peaks on the dividend record date, consistent with the findings of Dixon et al. (2021).

The peak ranges between 3 and 6 percent, with, typically, slightly more lending in Sweden than in the other countries. In 2016 the peak in Denmark shrinks consistent with the fact that the reform was introduced in mid-2016. After 2016, the evidence for excess lending in Denmark disappears, whereas a peak in lending remains present in the other countries.

Figure 5 plots the coefficients from Figure 4 aggregated by the pre-reform period, the reform year, and the post-reform period, together with a 95-percent confidence interval. Panel A presents the results for Denmark while panel B presents the average of the control group. The figure shows that prior to the reform excess lending is significantly positive. After the reform, the peak in Denmark all but disappears. Hence, prior to the reform DWT arbitrage was common in the Nordic financial markets. However, the reform has eliminated the phenomenon in Denmark.

The magnitude of the effect we find is large. Prior to 2016 the average peak in excess stocks on loan is around 4 percentage points of the public float. Outside of the event window the average stocks on loan represent 0.9 percent of the public float (see Table 2). Therefore, the peak represents a $4/0.9 \approx 444$ percent increase in loans relative to regular trading days. For comparison, in the US Dixon et al. (2021) find that excess stocks on loan peaks by 0.6 percent point of the public float. Thus the peak in the Nordics is around 6.5 times larger than in the US, consistent with the much stronger incentive for DWT arbitrage in the Nordics than in the US.

4.1.1 Heterogeneity

We consider heterogeneity in the effect size by market capitalization and dividend yield. Intuitively, since larger companies are more likely to be included in the portfolio of international investors, we expect a stronger effect for larger companies. Additionally, arbitrage is more profitable for shares with a higher dividend yield. Hence, we expect the spike to increase with dividend yield. We present the results for Denmark in Figure 6 and Figure 7 and offer the same graphical evidence for Finland, Norway and Sweden in the Appendix (Figures A.1, A.2).

Figure 6 shows results by market capitalization. The evidence for the highest quartile is consistent with our hypothesis that DWT is most prominent for the largest companies. Specifically, the coefficients are not significant for the first quartile, and increase monotonically with the market capitalization of the underlying firm.

However, we find no clear pattern with respect to dividend yield (see Figure 7). This finding is consistent with the idea that DWT arbitrage is relatively cheap from the point of view of the investors. This suggests that for any dividend payment, no matter how small, it is profitable for foreign investors to engage in DWT arbitrage.

4.2 Other Outcome Variables

We estimate equation (1) on a number of additional outcome variables, with the purpose of clarifying the mechanism of the DWT arbitrage schemes. We first focus on the stocks available for lending as an outcome variable. The market for share lending is typically slack. That is, with regular fees the number of stocks available for lending is usually significantly larger than the stocks actually on loan. Dixon et al. (2021) find that in the US stocks available for lending reduce significantly around the ex-dividend day, in response to incentives discussed in section 2.3. However, Nordic tax systems do not provide the same incentives. Therefore, we expect that in the Nordic countries the supply for stocks does not drop.

We present the results for Denmark in Figure 8 and offer the same graphical evidence for the control group in Figure A.3. Figure 8 panel A is consistent with this hypothesis. If anything, in Denmark stocks available for lending are slightly above normal in the early years. After the reform the quantity available for loan is no longer elevated.

In Figure 8 panel B, we consider whether stock market turnover in Denmark is elevated during the dividend period. Buettner et al. (2019) uses turnover as a measure of cum-ex arbitrage. Consistent with their results, we also find that turnover is slightly elevated for most country-year pairs. In addition, we find that after the reform, excess turnover becomes non-significant in Denmark. However, when comparing Figure 5 to Figure 8 panel B, the most important difference is in the scale. Excess turnover concerns, at most, 0.2 percent of the public float. Excess lending is around one order of magnitude larger. We conclude that DWT arbitrage has a much larger effect on the lending market than on the regular stock market.

In Figure 8 panel C, we plot the cost of borrowing. Dixon et al. (2021) find that the cost of borrowing is significantly higher during a dividend payment. Using Markit's 10-point scale for the borrowing fee as a measure, we do not confirm this finding in the sense that the excess cost of borrowing in the event window is typically not significantly different from zero.

Finally, in panel D and E of Figure 8, we consider whether DWT arbitrage involves a few big players, or whether many parties are involved. We use a Herfindahl index for borrower and lender concentration, calculated by Markit, to see whether dividend periods are associated with an increase in borrower and/or lender concentration. The Figures clearly show that DWT is a wide-spread phenomenon. Prior to the reform, excess borrower and lender concentration is negative indicating that there are more active players in the lending market during dividend payments, than on regular days. In the reform year this excess concentration, surprisingly turns positive. In the post-reform period excess lender and borrower concentration is non-significant during the event window.

5 Welfare Effects

In this section, we build a simple formal model on the welfare effects of DWT enforcement, and quantify it empirically. The main purpose of the model is to create a better understanding of how enforcement can affect welfare. The second subsection is devoted to estimating the welfare effect empirically.

5.1 Formal Model

The European DWT is effectively a tax on foreign investors. The reason is that domestic investors are reimbursed for DWT. Therefore, to analyze the welfare impacts of the reform, we model the following three stakeholders. The government, which collects DWT revenue, foreign investors whose effective DWT rate is affected by enforcement shock, because they are no longer able to partipate in cum-cum transactions and domestic companies whose profitability (in part) depends on FPI.

We model domestic welfare as the weighted sum of tax revenue and domestic-company surplus, which from now on we simply refer to as profits:

$$W = T + \eta\pi, \tag{2}$$

where η denotes the weight the government assigns to profits relative to tax payments.

We assume profits depend positively on FPI I, and negatively on the cost of capital. The cost of capital, in turn, depend positively on the amount of dividends the company pays out. For simplicity, we assume profits are quasi-linear in I, such that profits can be written as:

$$\pi = I - c(D). \tag{3}$$

We assume the cost of capital, $c(\cdot)$, are increasing and convex.

FPI is assumed to depend positively on after-DWT dividend payments. We write this (with some abuse of notation) as:

$$I = I((1-\tau)D). \tag{4}$$

We assume $I(\cdot)$ is an increasing and concave function, such that an increase in dividends attracts more foreign investment, but at a diminishing rate.

The effective tax tax rate τ is defined as total DWT payments divided by total dividends to foreign investors. The effective rate depends partially on the statutory rate and partially on tax enforcement, since higher enforcement implies that foreign investors are less able to avoid DWT. In our empirical setting we do not have variation in the statutory tax rate. Therefore, to ease notation, we simply model an increase in enforcement as an increase in the effective

tax rate τ.

Tax revenue is the product of the effective tax rate, FPI and dividends:

$$T = \tau I D. \tag{5}$$

We now turn to the equilibrium conditions. We assume the company maximizes profits by choosing dividends. Formally, the company maximizes:

$$\mathcal{D}(\tau) \equiv \arg\max_{D} I((1-\tau)D) - c(D), \tag{6}$$

where $\mathcal{D}(\tau)$ denotes the equilibrium amount of dividends a company pays out. $\mathcal{D}(\tau)$ is defined implicitly through the first-order condition:

$$(1-\tau)I'((1-\tau)D) = c'(D), \tag{7}$$

which states that in equilibrium dividends should be chosen such that the marginal increase in portfolio investment equals the marginal cost of capital.

Equilibrium FPI can be found by substituting equilibrium dividends $\mathcal{D}(\tau)$ into (4):

$$\mathcal{I}(\tau) = I((1-\tau)\mathcal{D}(\tau)). \tag{8}$$

With the equilibrium conditions in place, we can find the welfare implications of an increase in enforcement by substituting the equilibrium conditions (6) and (8) into domestic welfare (2) and taking the derivative with respect to the effective tax rate τ:

$$\begin{aligned}
\frac{dW}{d\tau} &= \frac{d\left[\tau\mathcal{I}(\tau)\mathcal{D}(\tau) + \eta I(\tau) - c(D(\tau))\right]}{d\tau} \\
&= \underbrace{\overbrace{\mathcal{I}(\tau)\mathcal{D}(\tau)}^{M} + \overbrace{\tau(\mathcal{I}'(\tau)\mathcal{D}(\tau) + \mathcal{I}(\tau)\mathcal{D}'(\tau)}^{B}}_{\text{Tax Revenue Effect}} + \\
&\quad \underbrace{\eta\mathcal{I}'(\tau)}_{\text{FPI Effect}} - \\
&\quad \underbrace{\eta c'(\mathcal{D}(\tau))\mathcal{D}'(\tau)}_{\text{Dividend Effect}}.
\end{aligned} \tag{9}$$

A change in enforcement affects welfare in three ways.[15] First, enforcement affects tax revenue. This effect can further be subdivided in a mechanical effect (labeled M), which measures the increase in tax revenue if the tax base remains constant, and a behavioral effect (labeled B), which measures the change in tax revenue as a result of behavioral responses in FPI ($\mathcal{I}'$), and in dividends ($\mathcal{D}'$). In addition, to the tax revenue effect, there is a potential loss in FPI because enforcement discourages FPI (labeled FPI effect). Finally, the reform affects the incentive for firms to pay out dividends, which affects the cost of capital (labeled Dividend Effect).

Relative to welfare analysis in the context of domestic taxation a number of issues stand out. With domestic taxation, if the welfare weight of all stakeholders is assumed to be equal (as in e.g. Chetty, 2009), the mechanical change in tax revenue M does not have a first-order welfare effect. In addition, changes in profits that result from changes in dividends do not constitute first-order welfare effects. The reason is that i.) mechanical transfers do not affect welfare by virtue of equal welfare weights on all stakeholders, and ii.) changes in dividends do not have first-order effects on profits by virtue of the envelope theorem. The welfare loss of taxation is than solely determined by the behavioral effect B. As a result of this, most of the empirical literature on domestic taxation aims to separately identify the behavioral effect from the mechanical effect (Hendren, 2016; Hendren and Sprung-Keyser, 2020).

However, in the context of international taxation it makes little sense to assign equal weight to all stakeholders. Specifically, domestic policy makers are unlikely to care about the surplus of foreign investors. As a result, mechanical transfers from foreigners to domestic stakeholders or vice versa result in first-order welfare effects. Hence, in our setting separately identifying the behavioral effect (B) from the mechanical effect (M) is not crucial to understand the welfare effects of the reform. On the other hand, in our setting we do need to quantify the effect of the reform on domestic company profitability.

[15] We have deliberately decided not to use the envelope theorem to simplify equation (9). To understand why, note that applying the envelope theorem to equation (6) yields the following condition:

$$\frac{d\left[\mathcal{I}(\tau) - c(\mathcal{D}(\tau))\right]}{d\tau} = -\mathcal{D}(\tau)I'((1-\tau)\mathcal{D}(\tau)).$$

The right-hand side can be interpreted as the derivative of FPI with respect to the reform, keeping constant dividends. From an empirical perspective the issue is that estimating the causal effect of the reform on FPI, while controlling for changes in dividend payments is non-trivial. It is easier to identify the unconditional effect of the reform on investment/dividends ($\mathcal{I}'(\tau)$,$\mathcal{D}'(\tau)$). We therefore opt not to apply the envelope theorem here, and instead phrase (9) in terms of unconditional effects.

Equation (9) provides clear empirical guidance on how to estimate the welfare effect of the enforcement shock. The welfare effect is driven by three parameters: the tax-revenue effect $(M + B)$, the effect of the reform on FPI, $\mathcal{I}'(\tau)$, and the effect on dividends $\mathcal{D}'(\tau)$. In the next subsection we quantify these effects empirically.

5.2 Empirical Quantification of Welfare Effects

Tax Revenue. We first consider the effect of the reform on net DWT revenue. Given that tax revenue is recorded at the yearly level, and thus, inference has to be conducted on a small sample with only four countries over 10 years, we rely on Synthetic DiD (Arkhangelsky et al., 2021). Synthetic DiD has two advantages over regular regression approaches. First, the method can control for pre-trends by taking a weighted average over the control units that best fits the pre-reform trajectory for the treatment group. Second, the method allows for valid inference in a setting with only one treated unit (in our case Denmark).

Figure 9 shows the result comparing net DWT revenue in Denmark to synthetic Denmark, which is constructed as a weighted average of Finland, Norway and Sweden. Before the reform, trends between Denmark and synthetic Denmark are parallel. After the reform the trends immediately diverge. In column 1 of Table 3 we present quantitative estimates. The estimated causal effect on annual DWT revenue is large at around 1.3 billion USD or about a 130 percent of 2014 tax revenue. The causal effect is precisely estimated with a small standard error.

To better understand the mechanism of why tax revenue in Denmark increases Figure A.4 plots reimbursements together with net tax revenue over time. In Denmark between 2014 and 2017 reimbursements dropped from 58 percent of gross tax revenue, to 20 percent of gross tax revenue, suggesting that the reduction in reimbursements is the main driver of the strong increase in net DWT revenue. This mechanism is consistent with a causal effect of the reform.

FPI We proceed by analysing whether the reform has affected FPI. To determine the effect of enforcement on FPI, we rely on bilateral IMF data on equity holdings. We compare equity holdings of US investors in Danish stocks to a synthetic counterpart made of US investment in Finnish, Norwegian and Swedish stocks.

We present results in Figure 10 and Table 3. Panel A of Figure 10 (Column 2 in Table 3)

describes the investment behavior of all fund managers, and Panel B in Figure 10 (column 3 in Table 3) focuses on fund managers of Insurance Companies and Pension Funds. This second group is of particular interest since US Pension Funds are usually partially or fully exempt from paying taxes in the US. Therefore, they have no tax base against which they can credit DWT payments in Europe. As can be seen in both Figure 10 and Table 3, US investment of both groups of investors to Denmark decreased relative to the synthetic control, but the effect is not statistically significant.

Our results are slightly surprising in the context of findings in Jacob and Todtenhaupt (2020). Using bilateral IMF portfolio data, Jacob and Todtenhaupt (2020) find that an increase in the DWT treaty rate between two countries results in a reduction in bilateral portfolio investment. Given that an increase in DWT enforcement increases the effective DWT rate, one would expect the Danish reform to result in a decrease in FPI. One potential explanation for why we do not find an effect is that the enforcement shock in Denmark may not be as salient as a change in the DWT treaty rate.

Dividend Yield. Next, we turn to the effect of the reform on dividend policy. For this part of the analysis we elect to use a Regression-based Event Study, rather than synthetic DiD for two reasons. First, we have company-level data with many treated units, implying that we can rely on standard inference. Second, the regression-method allows us to include industry$\times$ year fixed effects which control for common shocks to specific industries that may affect dividend yield, whereas synthetic DiD does not allow for such controls. We run the following regression equation:

$$DividendYield_{ijk} = \alpha_i + \eta_{jk} + \beta_k I(i \in Denmark) + \epsilon_{ijk}, \tag{10}$$

where $DividendYield_{ijk}$ is the dividend yield of company i, in sector j and year k. As an alternative, we also consider a binary indicator equal to 1 if $Dividend\_Yield_{ijk}$ is above zero ($I(Dividends) > 0$) as an outcome variable. $I(i \in Denmark)$ is an indicator function that equals 1 if a company is located in Denmark. α_i represent firm-fixed effects, and η_{jk} are sector-time fixed effects. The sector of a company is defined as the four digit Standard Industrial Classification (SIC) code available from Compustat. The coefficient of interest is β_k which estimates the DiD between i.) Denmark and the control group, and ii.) year k and the base

year.

We plot the results in Figure 11. We find that post-reform, Danish companies do not change their dividend policy. This result is also somewhat surprising given that there exists strong evidence that regular dividend taxes affect dividend policy. For instance, Poterba (2004) and Chetty and Saez (2005) find that the US dividend tax cuts in 2003 increased dividend payouts.[16] Jacob and Jacob (2013) provide similar findings on the basis of world-wide data.[17] A potential explanation is that regular dividend taxes apply to a large share of domestic investors. In contrast, DWT apply only to foreign investors, which are a smaller share for most companies. Companies may not be willing to adjust their dividend policy on the basis of a change that only affects a minority of their shareholders.

Overall, our empirical analysis indicates that the enforcement shock in Denmark strongly increased tax revenue with no evidence of an effect on FPI or dividend policy. Therefore, in the context of our formal model (specifically, equation (9)) our conclusion is that monetized welfare in Denmark increases by 1.3 billion USD annually as a result of the enforcement shock.

6 Results from other European Countries

In this section we explore DWT arbitrage and reforms in the remainder of Europe. We first discuss the various reforms before turning to the results.

6.1 Reforms in other European Countries

Reforms in European countries can be broadly categorized into two groups. The first introduces additional documentation, which directly targets the loopholes exploited by cum-ex transactions. The second introduces a minimum holding period for DWT relief, effectively reducing the profitability of all short-term transactions around the ex-dividend date including cum-cum and cum-ex.[18]

[16] However, Yagan (2015) finds no evidence that the tax cut had positive effects on the real economy, suggesting these responses are mainly driven by substitution between different mechanisms to reward shareholders.

[17] The underlying mechanism is still a topic of discussion. See for instance, Chetty and Saez (2010); Koethenbuerger and Stimmelmayr (2021).

[18] The reform in Denmark we have discussed this far falls somewhere in the middle between these two extremes. On the one hand, the Danish reform requires additional documentation, which closes the cum-ex loophole. On the other hand, it introduces the concept of a beneficial owner which safeguards against cum-cum.

With respect to the set of reforms around minimum ownership periods, Germany introduced new legislation on January 1, 2016 according to which a refund for the DWT is granted only if the beneficiary has been the legal and economic owner of the underlying shares for at least 45 days around the dividend record date.[19] Belgium and France introduced similar legislation in 2019. However, given our sample period 2010-2019 these reforms are likely too late to be picked up in our analysis.

With respect to the second group of reforms, in Germany since January 1, 2012, the obligation to withhold the DWT is no longer on the dividend-distributing German corporation but rather on the custody bank of the final beneficiary. In addition, a tax voucher is required for claiming the refund of a DWT and such tax vouchers can be only obtained upon submission of extensive documentation from the beneficiary to central tax office, safeguarding against the possibility that one DWT payment is reimbursed twice.[20] In addition, Austria introduced a requirement for the submission of an electronic pre-application for obtaining the refund from a DWT.[21] Specifically, until December 31, 2018, foreign investors could request the refund from the DWT in the same year when the DWT is deducted. From January 1, 2019 on, the pre-application and thus also the actual refund request can only be filed after the end of the year when the DWT is deducted. In this way, the beneficiaries incur a liquidity cost which was absent before the requirement to fill in pre-application form. Finally, beginning on January 22, 2019, Belgium introduced the requirement to provide full ownership of the share as a pre-condition to obtain a refund for the DWT.[22]

6.2 Results

Figure 12 shows the size of the effect on the ex-dividend day for the excess stocks on loan for 14 European countries for 4 years. To create these maps we estimate Equation 1 on the number of stocks on loan as a percentage of the public float for each country. We then color-code each country according to the maximum number of excess stocks on loan in the $[-3, 3]$ window.

The most noticeable change occurs in Germany, which prior to its 2016 reform had the

[19] See Official Gazette of 26 July 2016 (BGBl. I 36/2016 at 1730) and Income Tax Act, section 36a.

[20] See Act on the Implementation of Directive 2009/65/EC on the coordination of laws, regulations and administrative provisions relating to undertakings for collective investments in transferable securities.

[21] See Sec. 240a of the Federal Fiscal Procedures Act.

[22] See articles 266(4) and 281/1 of Belgian Income Tax Code.

highest level of DWT arbitrage of all countries in our sample. After, the 2016-reform the spike in stocks on loan all but disappear (see the Online Appendix for a more detailed German case study). Similarly, Figure 12 provides clear evidence of both the Danish (2016) and the Austrian reform (2018).

However, it should also be noted that generally the amount of DWT arbitrage appears to be reducing across Europe even in countries that did not introduce a reform. We see two possible reasons for this general reduction. First, given the large size of the German financial market, there may have been spillover effects of the new German legislation. Alternatively, targeted tax audits and tax court rulings in Germany and Denmark appear to indicate that both cum-ex and cum-cum may have been illegal even prior to changes in legislation, which could result in penalties and sanctions.[23] As a result, investors may have become more reluctant to participate in DWT arbitrage.

Finally, it is notable that there is evidence of arbitrage in the UK, given that the UK does not levy a DWT. In Online Appendix Figure A.7, we show first that the spike in the stocks on loan in the UK are driven by DRIP-arbitrage as identified for Australia in Ang et al. (2019). Once we exclude dividend distributions with a DRIP the spike in the UK disappear entirely. In the Online Appendix, we present results where we control for DRIP explicitly in the analysis on the Nordic countries. We show that DRIP has very small effects on our results for the Nordic countries, indicating that the spikes we observe there relate to tax-arbitrage.

7 Conclusion

We investigate the effect of the European reforms aimed at preventing the DWT arbitrage around the dividend payout dates through the so-called cum-cum and cum-ex schemes. We provide causal evidence of the effectiveness of the 2016 Danish reform in removing the possibility to conduct such tax arbitrage schemes. We confirm such evidence when investigating the effect of similar reforms in other major EU countries. Our welfare analysis provides important insights on the effect of the Danish reform on company and investor behaviour. Post-reform,

[23] In this regards, in August 2015, the Danish tax authorities stopped all DWT reimbursements due to alleged tax fraud (EY, 2020). While in the same period, in Germany, the fiscal authorities denied for the first time the reimbursement on the DWT in a cum-cum transaction case Junge and Kleutgens (2016)

Denmark experienced a substantial increase in DWT revenues. At the same, Danish companies did not change their dividend policy and foreign investors did not substantially change their equity holdings in Denmark.

Although the results of our analysis provide evidence of the success of the Danish reform in countering existing tax arbitrage scheme, policymakers attention to cum-cum and cum-ex transactions should remain high. There remains a strong incentive for the financial sector to develop products or transactions that allow investors to avoid the DWT. Therefore, one could expect the emergence of new channels through which investors will attempt to remove the cost related to DWT. In this regard, expert reports suggest that cum-cum and cum-ex transactions are still undertaken (Spengel, 2020; Deutscher Bundestag, 2020). Thus, further governmental action and supranational cooperation is needed to close the tax loopholes and safeguard against tax base erosion.

References

Akhmedov, Umid, and Keith Jakob (2010) 'The ex-dividend day: Action on and off the Danish exchange.' *Financial Review* 45(1), 83–103

Almunia, Miguel, and David Lopez-Rodriguez (2018) 'Under the radar: The effects of monitoring firms on tax compliance.' *American Economic Journal: Economic Policy* 10(1), 1–38

Ang, Tze Chuan'Chewie', Xin Simba Chang, Xiaoxiong Hu, and Patrick Verwijmeren (2019) 'Equity financing, equity lending, and price pressure: The case of DRIP arbitrage.' Nanyang Business School Research Paper, 20-03 Singapore

Arkhangelsky, Dmitry, Susan Athey, David A Hirshberg, Guido W Imbens, and Stefan Wager (2021) 'Synthetic difference-in-differences.' *American Economic Review* 111(12), 4088–4118

Buettner, Thiess, Carolin Holzmann, Felix Kreidl, and Hendrik Scholz (2019) 'Withholding-tax non-compliance: The case of cum-ex stock-market transactions.' SSRN Working Paper No. 2960015 Nurnberg

Carrillo, Paul, Dina Pomeranz, and Monica Singhal (2017) 'Dodging the taxman: Firm mis-

reporting and limits to tax enforcement.' *American Economic Journal: Applied Economics* 9(2), 144–64

Chetty, Raj (2009) 'Sufficient Statistics for Welfare Analysis: A Bridge Between Structural and Reduced-form Methods.' *Annu. Rev. Econ.* 1(1), 451–488

Chetty, Raj, and Emmanuel Saez (2005) 'Dividend Taxes and corporate behavior: Evidence from the 2003 Dividend Tax Cut.' *Quarterly Journal of Economics* 120(3), 791–833

Chetty, Raj, and Emmanuel Saez (2010) 'Dividend and corporate taxation in an agency model of the firm.' *American Economic Journal: Economic Policy* 2(3), 1–31

Christoffersen, Susan EK, Christopher C Geczy, David K Musto, and Adam V Reed (2005) 'Crossborder dividend taxation and the preferences of taxable and nontaxable investors: Evidence from Canada.' *Journal of Financial Economics* 78(1), 121–144

Collier, Richard S (2020) *Banking on Failure: Cum-ex and why and how Banks Game the System* (Oxford University Press)

Cooper, I. A., and E. Kaplanis (1986) *Costs to cross-border investment and international equity market equilibrium. In Recent developments in corporate finance* (Cambridge, MA: Cambridge University Press)

Cooper, Ian, and Evi Kaplanis (1994) 'Home bias in equity portfolios, inflation hedging, and international capital market equilibrium.' *The Review of Financial Studies* 7(1), 45–60

CORRECTIV (2021) 'The cumex files 2.0.' Retrieved from https://correctiv.org/en/top-stories/2021/10/21/cumex-files-2/

Deutscher Bundestag (2020) 'Expert public hearing - german parliament.' `https://www.bundestag.de/dokumente/textarchiv/2020/kw37-pa-finanzen-cum-ex-707204`. Accessed on 20 January 2022

Dhaliwal, Dan, and Oliver Zhen Li (2006) 'Investor tax heterogeneity and ex-dividend day trading volume.' *The Journal of Finance* 61(1), 463–490

Dixon, Peter N, Corbin A Fox, and Eric K Kelley (2021) 'To own or not to own: Stock loans around dividend payments.' *Journal of Financial Economics* 140(2), 539–559

Dutt, V., and Spengel, C., and Vay, H. (2018) 'Dividendenstripping durch Cum/Ex- und Cum/Cum-geschäfte – analyse aktueller entwicklungen.' `https://steuerrecht.uni-koeln.de/sites/steuerrecht/StuW/Dutt__Spengel__Vay.pdf`. Accessed on 18 January 2022

Endres, Dieter, and Christoph Spengel (2015) *International Company Taxation and Tax Planning* (Cambridge, MA: Cambridge University Press)

European Securities and Markets Authority (2020) 'Final report: On Cum/Ex, Cum/Cum and withholding tax reclaim scheme.' `https://www.esma.europa.eu/sites/default/files/library/esma70-155-10272_final_report_on_cum_ex_and_other_multiple_withholding_tax_reclaim_schemes.pdf`. Accessed on 14 July 2021

EY (2020) 'Denmark proposes new withholding tax regime for dividends.' `https://www.ey.com/en_gl/tax-alerts/denmark-proposes-new-withholding-tax-regime-for-dividends`. Accessed on 18 January 2022

Fack, Gabrielle, and Camille Landais (2010) 'Are tax incentives for charitable giving efficient? evidence from france.' *American Economic Journal: Economic Policy* 2(2), 117–41

Griffin, John M (2021) 'Ten years of evidence: Was fraud a force in the financlial crisis?' *Journal of Economic Literature* 59(4), 1293–1321

Hartzmark, Samuel M, and David H Solomon (2013) 'The dividend month premium.' *Journal of Financial Economics* 109(3), 640–660

Henderson, Brian J, and Neil D Pearson (2011) 'The dark side of financial innovation: A case study of the pricing of a retail financial product.' *Journal of Financial Economics* 100(2), 227–247

Hendren, Nathaniel (2016) 'The policy elasticity.' *Tax Policy and the Economy* 30(1), 51–89

Hendren, Nathaniel, and Ben Sprung-Keyser (2020) 'A unified welfare analysis of government policies.' *The Quarterly Journal of Economics* 135(3), 1209–1318

Henry, Tyler R, and Jennifer L Koski (2017) 'Ex-dividend profitability and institutional trading skill.' *The Journal of Finance* 72(1), 461–494

Jacob, Marcus, and Martin Jacob (2013) 'Taxation, dividends, and share repurchases: Taking evidence global.' *Journal of Financial and Quantitative Analysis* 48(4), 1241–1269

Jacob, Martin, and Maximilian Todtenhaupt (2020) 'Withholding taxes, compliance cost and foreign portfolio investment.' *Working Paper*

Junge, Volker, and Ingo Kleutgens (2016) 'New German tax rules to reduce cum/cum trades.' *Tax Notes Internatonal* 83(9), 799–801

Karpoff, Jonathan M, and Ralph A Walkling (1990) 'Dividend capture in NASDAQ stocks.' *Journal of Financial Economics* 28(1-2), 39–65

Keys, Benjamin J, Amit Seru, and Vikrant Vig (2012) 'Lender screening and the role of securitization: evidence from prime and subprime mortgage markets.' *The Review of Financial Studies* 25(7), 2071–2108

Keys, Benjamin J, Tanmoy Mukherjee, Amit Seru, and Vikrant Vig (2010) 'Did securitization lead to lax screening? Evidence from subprime loans.' *The Quarterly journal of economics* 125(1), 307–362

Kleven, Henrik Jacobsen, Martin B Knudsen, Claus Thustrup Kreiner, Søren Pedersen, and Emmanuel Saez (2011) 'Unwilling or unable to cheat? Evidence from a tax audit experiment in denmark.' *Econometrica* 79(3), 651–692

Koethenbuerger, Marko, and Michael E Stimmelmayr (2021) 'The Efficiency Costs of Dividend Taxation with Managerial Firms.' *The Economic Journal.* ueab064

Kopczuk, Wojciech, Justin Marion, Erich Muehlegger, and Joel Slemrod (2016) 'Does tax-collection invariance hold? Evasion and the pass-through of state diesel taxes.' *American Economic Journal: Economic Policy* 8(2), 251–86

Lakonishok, Josef, and Theo Vermaelen (1986) 'Tax-induced trading around ex-dividend days.' *Journal of Financial Economics* 16(3), 287–319

Levine, Ross (2005) 'Finance and growth: Theory and evidence.' *Handbook of economic growth* 1, 865–934

McDonald, Robert L (2001) 'Cross-border investing with tax arbitrage: The case of German dividend tax credits.' *The Review of Financial Studies* 14(3), 617–657

Pérignon, Christophe, and Boris Vallée (2017) 'The political economy of financial innovation: evidence from local governments.' *The Review of Financial Studies* 30(6), 1903–1934

Petkova, Kunka (2020) 'Withholding tax rates on dividends: Symmetries vs. asymmetries in double tax treaties.' *WU International Taxation Research Paper Series*

Poterba, James (2004) 'Taxation and corporate payout policy.' *American Economic Review* 94(2), 171–175

Sato, Yuki (2014) 'Opacity in Financial Markets.' *The Review of Financial Studies* 27(12), 3502–3546

Slemrod, Joel (2019) 'Tax compliance and enforcement.' *Journal of Economic Literature* 57(4), 904–54

Spengel, Christoph (2016) 'Dringender handlungsbedarf bei cum/ cum-geschäften.' *Der Betrieb*

_ (2020) 'Expert public hearing - german parliament.' `https://www.bundestag.de/resource/blob/790436/98678f1af3b8e413dc696a9bfddc975c/12-Spengel-data.pdf`. Accessed on 20 January 2022

_ (2021a) 'Estimation of fraudulent tax reclaims caused by cum/ex - ard transactions.' `https://www.bwl.uni-mannheim.de/media/Lehrstuehle/bwl/Spengel/Dokumente/Medien/Steuerschaden_Cum-ExADR_Okt2021.pdf/flipbook`. Accessed on 20 January 2022

_ (2021b) 'Estimation of the tax revenue loss caused by Cum/Cum transactions.' https://www.bwl.uni-mannheim.de/media/Lehrstuehle/bwl/Spengel/Dokumente/Medien/Steuerschaden_Cum-Cum_update.pdf/flipbook. Accessed on 20 January 2022

_ (2021c) 'Public hearing of the subcommittee on tax matters of the european parliament on the Cum-Ex/Cum-Cum scandal.' https://www.europarl.europa.eu/cmsdata/230392/Christoph%20Spengel%20statement.pdf. Accessed on 14 July 2021

Spengel, Christoph, Verena Dutt, and Heiko Vay (2017) 'Estimation of fraudulent tax reclaims caused by cum/ex - ard transactions.' https://www.bwl.uni-mannheim.de/media/Lehrstuehle/bwl/Spengel/Dokumente/Medien/Steuerschaden_Cum-Ex__2017-03-31_.pdf/flipbook. Accessed on 20 January 2022

Thornock, Jacob (2013) 'The effects of dividend taxation on short selling and market quality.' *The Accounting Review* 88(5), 1833–1856

Wigan, Duncan (2019) 'Case study: The cum-cum and cum-ex schemes.' WorkingPaper D4.5, Coffers, Netherlands, September

Yagan, Danny (2015) 'Capital tax reform and the real economy: The effects of the 2003 dividend tax cut.' *American Economic Review* 105(12), 3531–63

Zingales, Luigi (2015) 'Presidential address: Does finance benefit society?' *The Journal of Finance* 70(4), 1327–1363

Figures and Tables

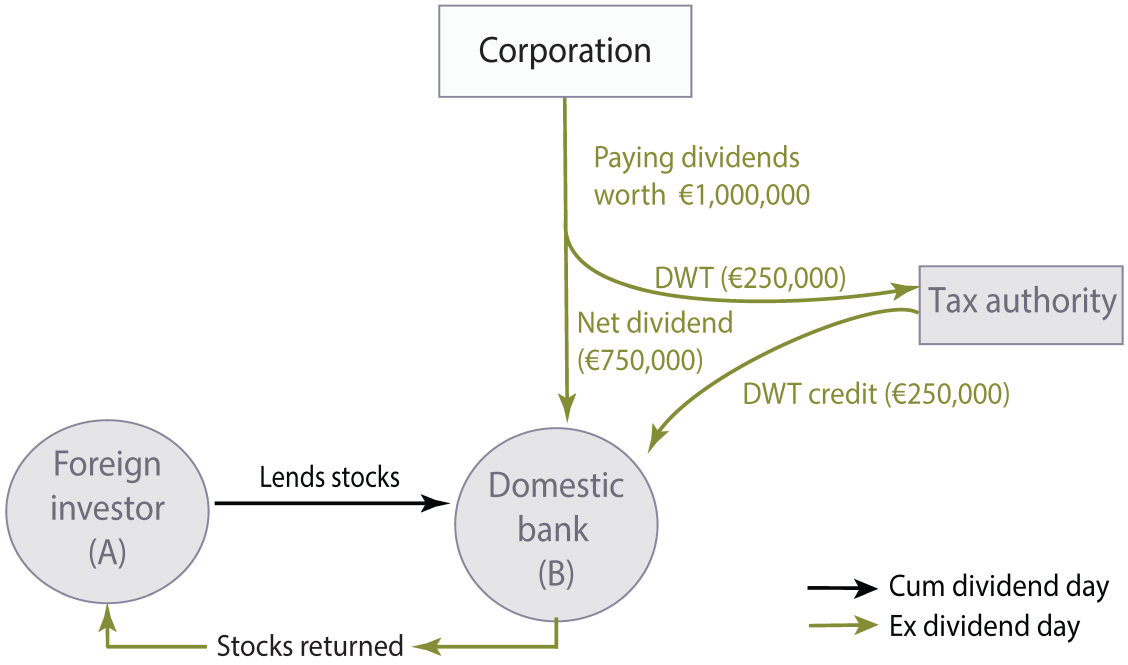


Figure 2: Example of a Cum-Cum Transaction

Notes: The figure represents an example of a cum-cum transaction. The black arrows indicate the period t-1 before the dividend payment date and the green arrows indicate the period t+1 after the dividend payment date. The bank B is borrowing the shares in the Corporation at t-1. B is a resident of the same country of the Corporation issuing the dividend and thus typically is entitled to a full reimbursement of the dividend withholding tax (DWT). While the investor A is not a resident of the same country and thus typically not entitle to a (full) reimbursement of the DWT. The DWT is assumed to be 25%. At t, the Corporation pay a net dividend payment of EURO 750,000 to B and withheld the DWT of EUR 250,000 to be directly remitted to the tax authority. At t+1, the tax authority reimburses the full amount of the DWT (DWT credit) to B.

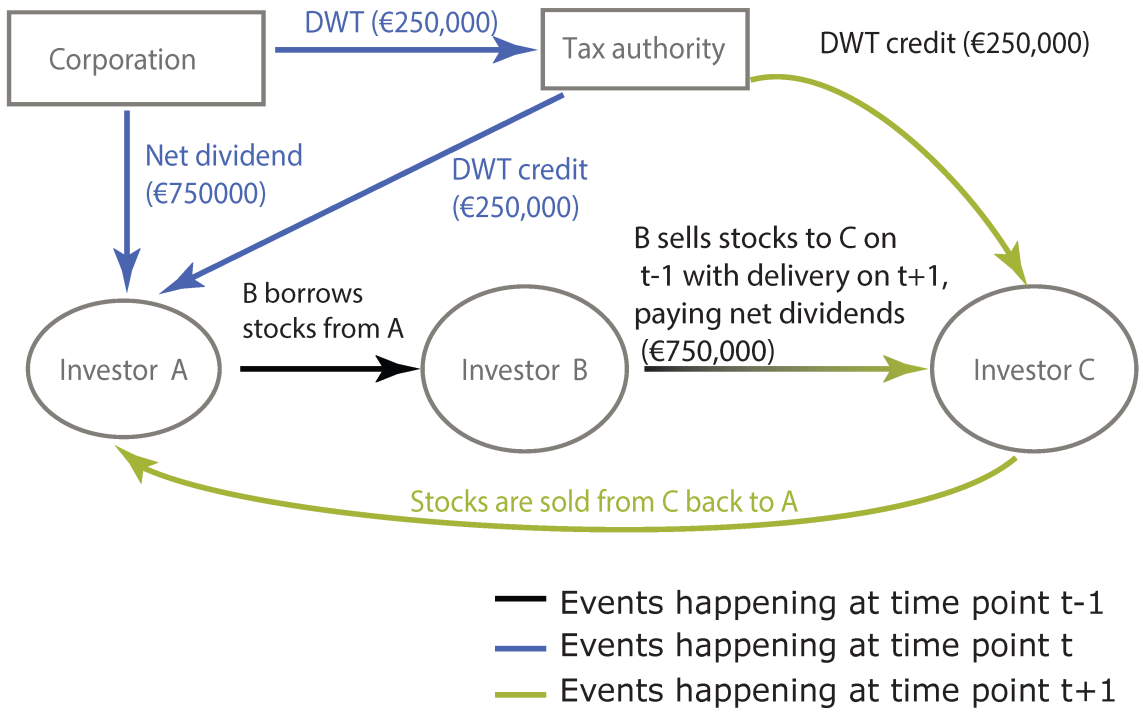
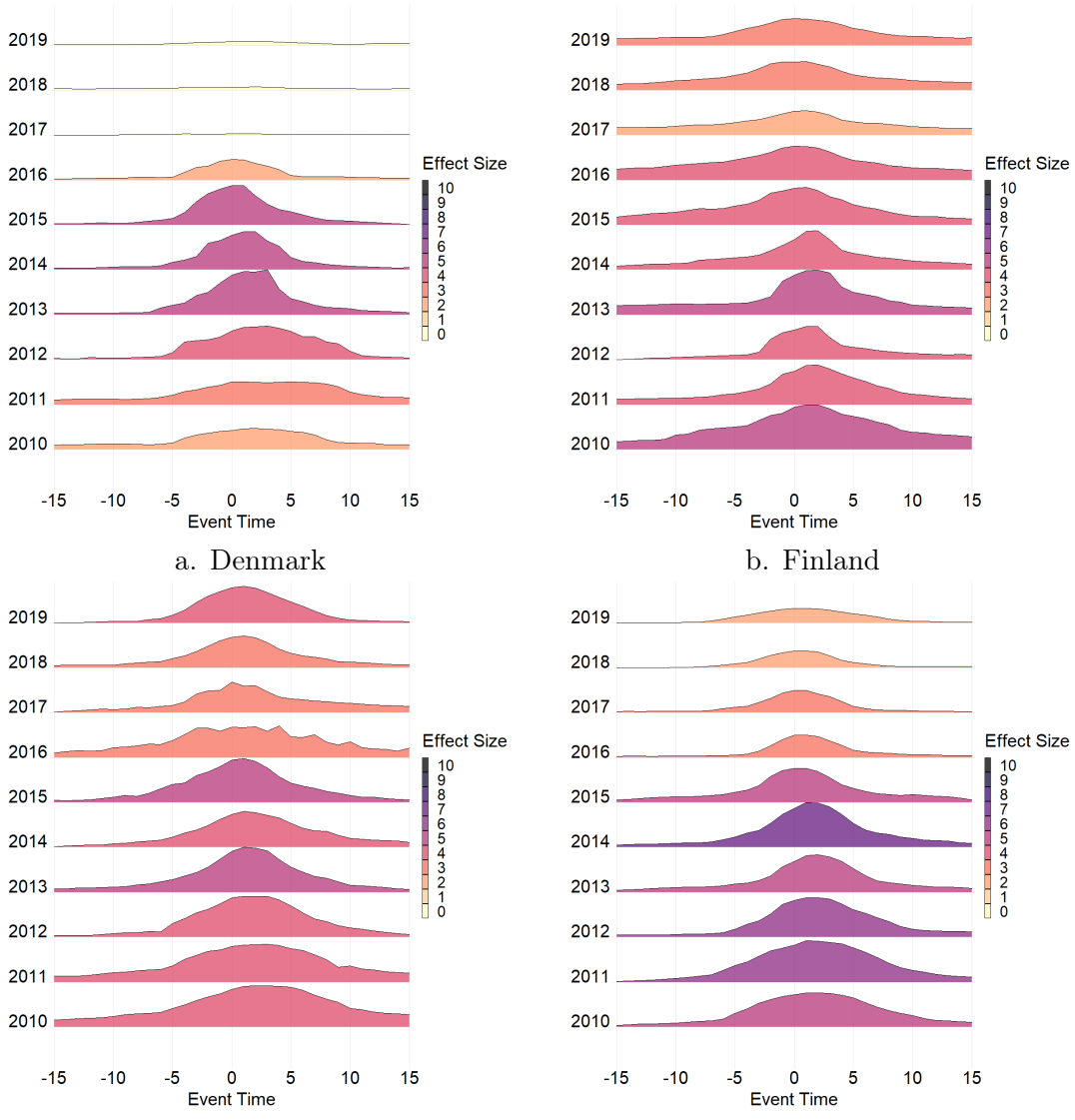


Figure 3: Example of a Cum-Ex Transaction

Notes: The figure represents an example of a cum-ex transaction. The black arrows indicate the period t-1 before the dividend payment date, the blue arrows indicate the period t of the dividend payment date, and the green arrows indicate the period t+1 after the dividend payment date. Investor A owns the shares in the Corporation at time t-1. At t-1, the investor B borrows the shares from investor A and sells the share to investor C with the delivery date t+1. At t, the Corporation pay a net dividend payment of EURO 750,000 to B and withheld the dividend withholding tax (DWT) of EUR 250,000 to be directly remitted to the tax authority (assuming a DWT rate of 25%). At t+1, investor A receives the net dividend payment while investor C receives a dividend compensation payment from B. Conditional on equal treatment of dividend payment and dividend compensation payment, both investors A and C receive a tax certificate. At t+1, the tax authority reimburses the full amount of the DWT (DWT credit) to investor A and C. Investor C sells the share to A at t+1.

Figure 4: Excess stocks on loan around the ex-dividend day



a. Denmark

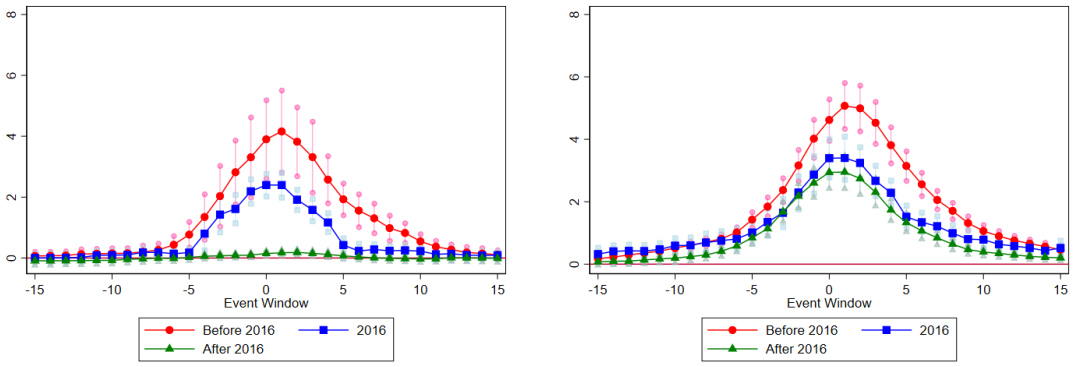
b. Finland

c. Norway

d. Sweden

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time where $\tau = 0$ is the ex-dividend date. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights, and plot the coefficients $\beta_{\tau k}$.

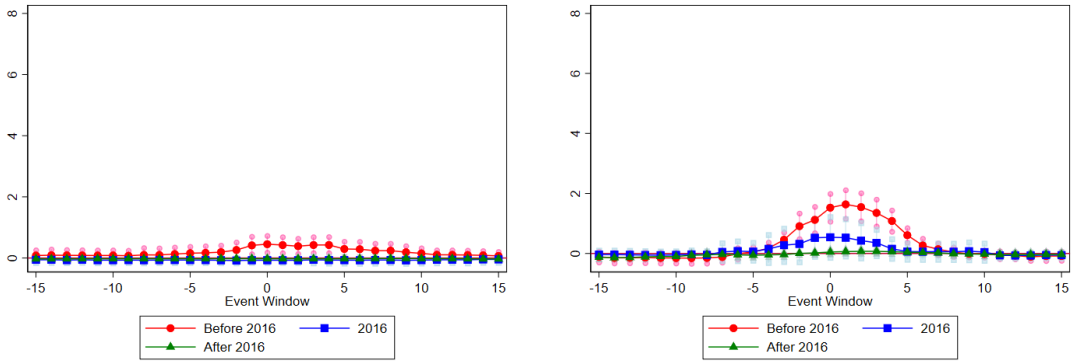
Figure 5: Excess stocks on loan aggregated by the treatment and control group, and treatment and control period



a. Denmark b. Control Group

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time where $\tau = 0$ is the ex-dividend date. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by i.) treatment group (Denmark)/control group (Finland, Norway and Sweden), and ii.) period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

Figure 6: Heterogeneity in excess stocks on loan with respect to market capitalisation for Denmark



a. Bottom Quartile

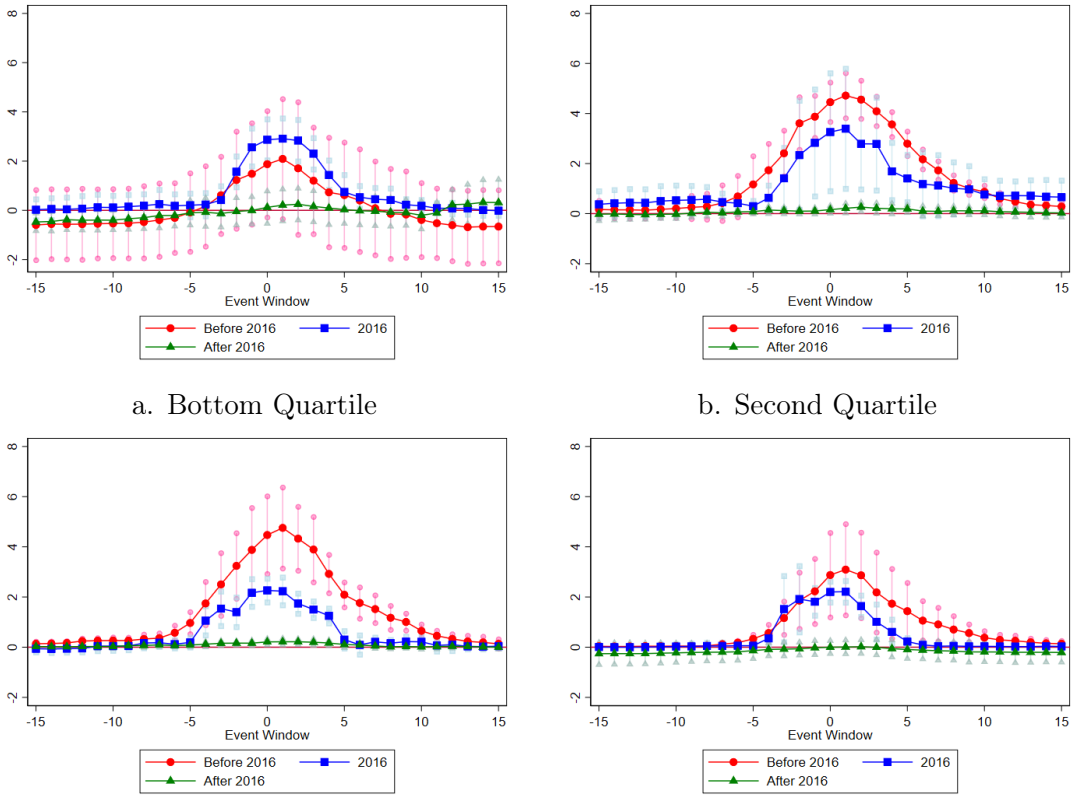
b. Second Quartile

c. Third Quartile

d. Top Quartile

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time - where $\tau = 0$ is the ex-dividend date - and by quartile of market cap. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by treatment group (Denmark), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

Figure 7: Heterogeneity in excess stocks on loan with respect to dividend yield for Denmark



a. Bottom Quartile

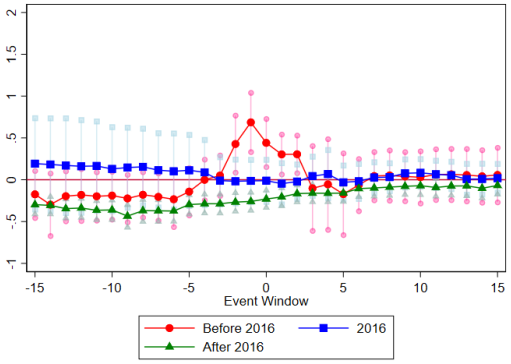
b. Second Quartile

c. Third Quartile

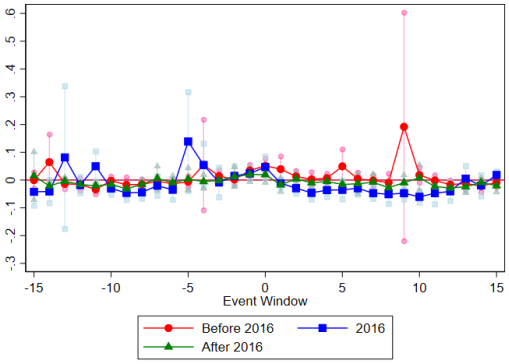
d. Top Quartile

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time - where $\tau = 0$ is the ex-dividend date - and by quartile of dividend yield. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by treatment group (Denmark), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

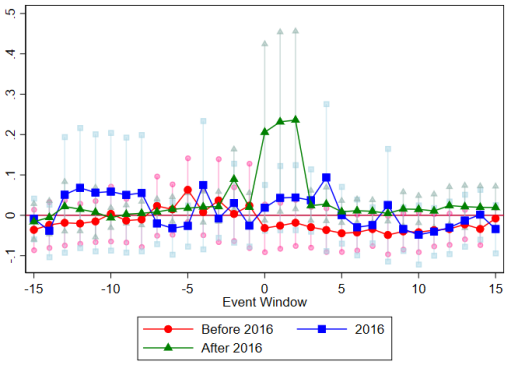
Figure 8: Event study for additional outcome variables for Denmark



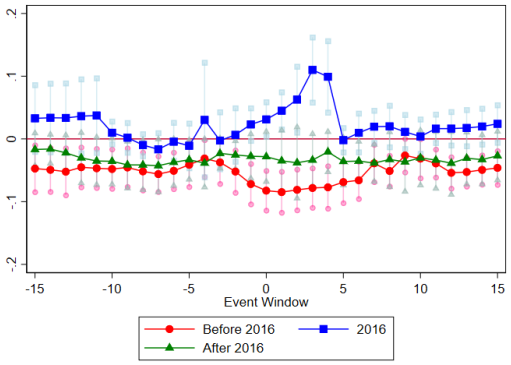
a. Quantity Available for Lending



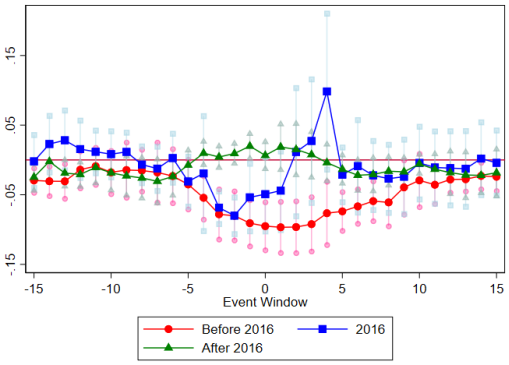
b. Turnover



c. Cost of Borrowing



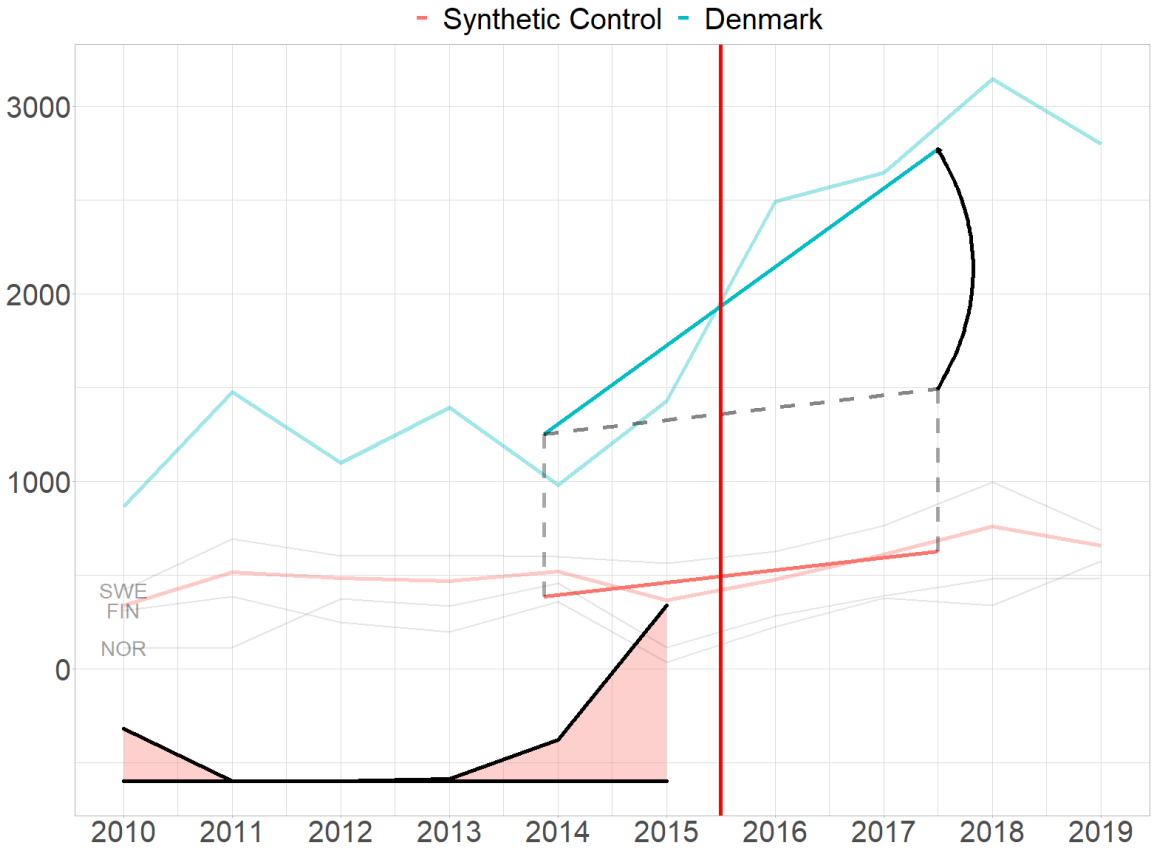
d. Borrower Concentration



e. Lender Concentration

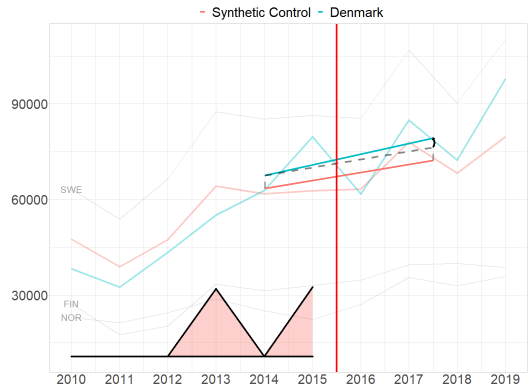
Notes: The Figure plots the outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each outcome variable is estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by treatment group (Denmark), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

Figure 9: The Effect of the Reform on Tax Revenue

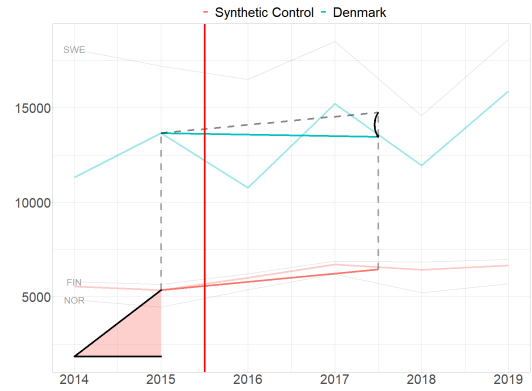


Notes: The figure shows the causal effect of the Danish reform on net DWT revenue estimated through synthetic DiD (Arkhangelsky et al., 2021). The blue line represents annual net DWT revenue from Denmark. The red line represents Denmark's synthetic control, which is a weighted average of Finland, Norway and Sweden. The thick red line represents a linear approximation of the trajectory of tax revenue in the synthetic control. The dotted line represents the same trajectory for Denmark in the counterfactual of parallel trends. The thick blue line represents the actual linearized trajectory for the Denmark. The arrow represents the estimated causal effect of the reform. Finally, the bottom panel represent time-weights used in the pre-reform to estimate the causal effect. Table 3 contains the set of synthetic weights, and quantifies the causal effect.

Figure 10: The Effect of the Reform on Foreign Equity Investment



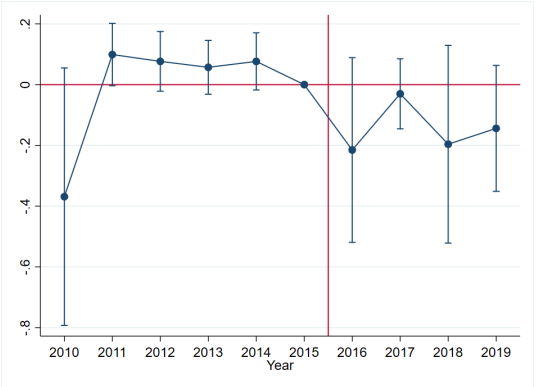
a. All Equity Investment



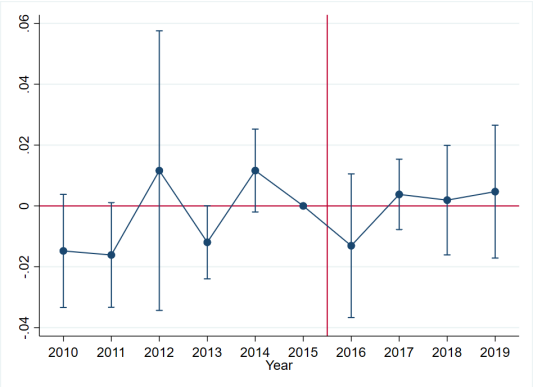
b. Investment by Insurance Companies and Pension Funds

Notes: The Figure shows the causal effect of the Danish reform on foreign equity investment estimated through synthetic DiD (Arkhangelsky et al., 2021). The blue line represents annual portfolio equity investments by, respectively all US fund managers into Denmark (panel a), and US fund managers of Insurance Companies and Pension Funds (panel b). The red line represents Denmark's synthetic control, which is a weighted average of equity investments from the US into Finland, Norway and Sweden. The thick red line represents a linear approximation of the trajectory of equity investment in the synthetic control. The dotted line represents the same trajectory for Denmark in the counterfactual of parallel trends. The thick blue line represents the actual linearized trajectory for Denmark. The arrow represents the estimated causal effect of the reform. Finally, the bottom panel represent time-weights used in the pre-reform to estimate the causal effect. Table 3 contains the set of synthetic weights, and quantifies the causal effect.

Figure 11: The Effect of the Reform on Dividend Policy



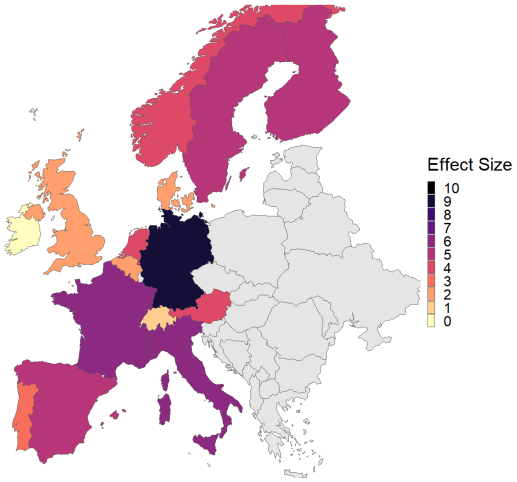
a. I(Dividends)>0



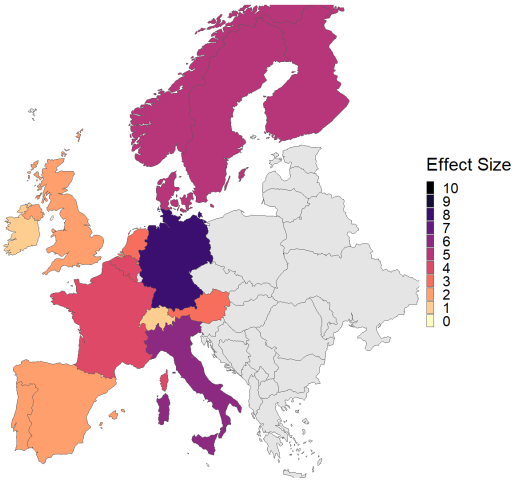
b. Dividend Yield

Notes: The Figure shows an event study comparing Denmark (treatment) to Finland, Norway and Sweden (control). The outcome variables are, respectively, the probability of a company paying dividends (panel a), and dividend yield (panel b). Coefficients are estimated with Regression Equation (10). Standard errors are clustered at the company level.

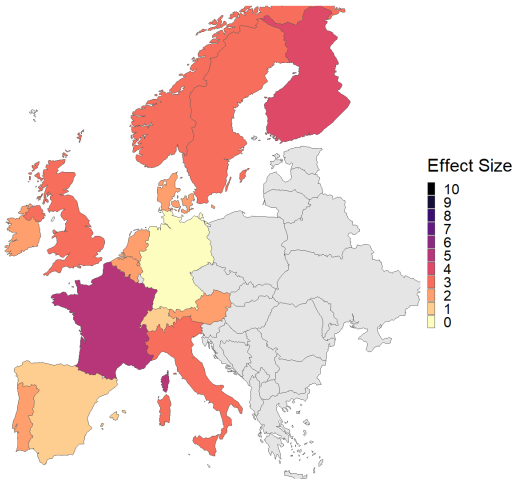
Figure 12: Excess stocks on loan in 15 European countries



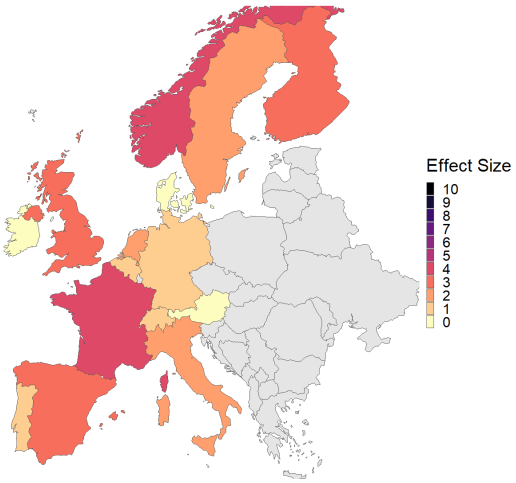
a. 2010



b.2013



a. 2016



b.2019

Notes: The map is color-coded according to the the maximum coefficient $\beta_{\tau k}$ from regression equation (1) subject to $\tau \in [-3, 3]$ by country and year. The outcome variable is the number of stocks on loan as a percentage of the public float. Non-s Standard errors are clustered at the issuing company level.to the shows the maximum absolute value of the excess stocks on loan in the $[-3, 3]$ centered around the ex-dividend date as a percentage of the public float. Non-significant estimates are color-coded as 0. Equation (1) is estimated with weighted least squares where we use the market-cap as regression weights. Standard errors are clustered at the issuing company level.

Table 1: DWT Rates Overview

Country	Non-Tax Treaty Rate	US Tax Treaty Rate
Denmark	0.27	0.15
Finland	0.20	0.15
Norway	0.25	0.15
Sweden	0.30	0.15

Notes: The table represents the DWT rate for the sample period (2010-2019) and for minority shareholders. The first column shows the DWT rates which apply in the case of no tax treaty between Denmark, Finland, Norway or Sweden and the investor's country of residence. The second column shows the reduced rate which applies according to the US tax treaty with Denmark, Finland, Norway or Sweden.

Table 2: Summary Statistics

	Denmark		Finland		Norway		Sweden		Outside
	Before	After	Before	After	Before	After	Before	After	Event Window
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Daily Data									
Stocks on Loan	4.069	1.380	5.615	3.642	4.362	3.713	6.108	3.755	1.283
	(2.245)	(1.475)	(3.530)	(2.323)	(2.414)	(2.400)	(3.668)	(2.535)	(1.941)
Stocks Available for Lending	15.14	16.57	13.97	14.76	9.421	10.58	17.17	15.35	14.48
	(6.420)	(5.983)	(7.272)	(7.729)	(4.332)	(5.472)	(8.190)	(6.554)	(6.992)
Turnover	0.232	0.198	0.383	0.245	0.249	0.171	0.380	0.297	0.253
	(0.216)	(0.144)	(0.381)	(0.199)	(0.282)	(0.149)	(0.350)	(0.266)	(0.408)
Cost of Borrowing	1.176	1.232	1.498	1.180	1.288	1.166	1.399	1.269	1.235
	(0.747)	(0.942)	(1.510)	(0.874)	(1.092)	(0.728)	(1.259)	(0.997)	(0.815)
Lender Concentration	0.167	0.253	0.215	0.215	0.164	0.184	0.203	0.229	0.253
	(0.152)	(0.181)	(0.191)	(0.193)	(0.156)	(0.156)	(0.175)	(0.182)	(0.188)
Borrower Concentration	0.232	0.256	0.175	0.214	0.158	0.241	0.198	0.236	0.257
	(0.166)	(0.154)	(0.169)	(0.186)	(0.155)	(0.137)	(0.168)	(0.162)	(0.169)
Number of Events	219	190	372	260	306	286	873	937	0
Panel B. Annual Data									
Dividend Yield	0.0189	0.0174	0.0423	0.0406	0.0328	0.0197	0.0339	0.0259	
	(0.00988)	(0.0110)	(0.0158)	(0.0230)	(0.0178)	(0.0135)	(0.0139)	(0.0174)	
US Equity Investment	51934.1	79208.5	27129.9	38191.8	24120.7	32843	73753.5	98160	
	(17519.3)	(15680.1)	(6816.9)	(2379.3)	(2625.6)	(4077.0)	(14428.3)	(12176.1)	
US Investment by Insurance and Pension Funds	12489	13458	5729	6733.5	4655	5626.3	17646.5	17049.5	
	(1646.1)	(2479.9)	(96.17)	(346.5)	(263.0)	(430.7)	(630.0)	(1911.5)	
Net DWT Revenue	1206.8	2768.8	254.7	377.7	250.8	408.9	578.8	780.9	
	(259.0)	(279.3)	(128.4)	(145.6)	(155.3)	(93.31)	(89.68)	(155.3)	
% Reimbursements	36.17	20	31.67	28.25	42.50	17.75	26.17	20.00	
	(17.22)	(0.816)	(29.49)	(14.86)	(22.30)	(3.775)	(9.326)	(7.439)	

Notes: Column 1-8 columns show the mean of the variable for event time [-3,3]. The last column shows the summary statistics outside the [-15,15] event window. The variables Stocks on Loan, Quantity available for lending and Turnover are represented as a percentage of public float. The cost of borrowing is scored from 1-10, where 1 represents the lowest cost. Lender and Borrower Concentration are a Herfindahl index of concentration. Dividend Yield is the average annual dividend yield by company. US Equity Investments and Investment by Insurance and Pension Funds represents the amount of investment by, respectively, all US fund managers and fund managers of insurance companies and pension funds into equities in the Nordic countries. Net DWT Revenue is the difference between gross DWT revenue and reimbursements measured in USD. % Reimbursements represent the Reimbursement as a percentage of Gross DWT Revenue. Statistics in Panel A, and dividend yield in panel B are weighted by market capitalization. Standard Deviations are in parenthesis.

Table 3: Synthetic Difference-in-Difference

		US Equity Investment	
	Net DWT Revenue	All Funds	Insurance and Pension Funds
	(1)	(2)	(3)
Panel A. Causal Effect			
SDiD Denmark	1276.3***	-4906.5	-933.6
	(24.3)	(3094.4)	(797.2)
Panel B. Synthetic Weights			
Finland	0.212	0.291	0.368
Norway	0.192	0	0.347
Sweden	0.596	0.613	0.285

Notes: Panel A represents the causal effect of the Danish reform on the outcome variable listed in the column title. The estimates are obtained via synthetic DiD. The standard error is obtained through the placebo method. See Arkhangelsky et al. (2021) for more details. Panel B represents the synthetic weights used for each of the three outcome variables.

Online Appendix

A1 Case Study Germany

In this Section, we study DWT arbitrage in Germany in more detail. The main purpose is i.) to compare our findings to the earlier study by Buettner et al. (2019), ii.) to compare the results from Germany to our main case study on the Nordic countries, and iii.) to quantify the importance of cum-cum relative to cum-ex.

The first reform targeting tax dividend arbitrage in Germany became effective on January 1st, 2012. The reform made the custody bank of the final beneficiary (and not the corporation issuing the dividend) responsible for withholding the DWT (see Buettner et al., 2019 for more details). This change ensured that the same entity would be responsible for both remitting the dividend tax as well as issuing the tax certificate. The reform eliminated the possibility to issue two certificates for a single DWT payment, and thereby prevented cum-ex transactions.

In August 2015, for the first time, the German federal tax court pronounced the final decision over a court case on a cum-cum transaction involving security lending. The judge ruled against the existence of an ownership transfer and thus the entitlement for a reimbursement of the DWT. Shortly after, in December 2015, the federal ministry of finance presented the draft of a law targeting such tax dividend arbitrage, the so-called Reform of Investment Taxation. According to the law proposal, a DWT reimbursement is granted only if the investors hold the stock for a window of at least 45 days around the ex-dividend date as the legal and economic owner. Days for which the taxpayers carried less than 70% of market risk are excluded. Also small investors (receiving annual dividends not exceeding EUR 20,000) are excluded.[24]

This law was approved in February 2016 and it was published on the official gazette on July 2016. Yet, it had a retroactive element as it started being effective as of January 1, 2016.

Similar to Denmark, the German DWT legislation in 2016 was issued in an effort to close down tax code vulnerabilities associated with cum-cum and cum-ex trading. However, there are two major differences. First, in 2012 Germany already passed legislation targeted at closing the cum-ex loophole. Second, contrary to Denmark, the legislation passed in 2016 introduced the concept of 45-day holding period. This legislation is comparable to legislation in the US

[24]For more details, see Junge and Kleutgens (2016)

and Australia.

Figure A.5 shows the effect of both reforms on excess stocks on loan, and excess transaction volume. Similar to Denmark, the excess number of stocks on loan decrease to approximately 0 after the 2016-reform takes effect, indicating the (close to) complete success of the 2016 reform at reducing DWT arbitrage.

Results for the 2012 reform, targeted at cum-ex, are less clear. Intuitively, a cum-ex transaction typically takes the form of a short sale (see also Section 2). Therefore, a cum-ex transaction consists of a sale, which is registered in the transaction volume data, as well as a loan, registered in the security-lending data. Hence, the 2012-reform which intended to tackle cum-ex should result in a drop in both lending and transaction volume. However, we observe a drop in transaction volume, while the excess stocks on loan remain constant.

The most likely explanation is that the drop in cum-ex transaction in 2012, as evidenced by the drop in the transaction volume, is countered by an increase in cum-cum transactions happening at the same time. Between 2010 and 2012 Germany was still affected by the financial crisis and the subsequent euro-zone crisis. Dividend payments were relatively low during this period. It is plausible that this also depressed the amount of cum-cum activity. After 2012 dividends, and as a consequence, cum-cum transactions picked up, which masks the effect of the 2012-reform in security-lending data. Note that this explanation is consistent with the general increase in stock lending observed throughout Northern-Europe in that period (see for instance Figure 12).

Also, note that excess stock lending is considerably higher than excess turnover. Before the reform excess turnover was, on average about 1.1 percent of the public float at the peak. In that same period, excess lending is around 9.0 percent of the public float.

We use these numbers to find an upper limit on the role of cum-ex relative to cum-cum. We make the following assumptions. First, we assume that the peak in turnover, at 1.1 percent, prior to 2012 was entirely due to cum-ex transactions. Second, we assume that the peak in excess lending in the same period, at 9.0 percent, contains both cum-cum and cum-ex transactions. In that case, cum-ex constitutes $1.1/9 = 12$ percent of the total amount of DWT arbitrage.

Note that this number presents an upper limit for the role of cum-ex in the sense that

i.) after 2012 in Germany the relative amount of excess transaction volume to excess stock lending is considerably smaller, ii.) Germany is an outlier in the sense that excess transaction volume in Germany is much larger than what we find in other European countries (see for instance Figures 8 and A.3 for the other Nordic countries), and iii.) we cannot be sure that the entire excess turnover before 2012 is the result of cum-ex. For instance, there is still a small spike remaining in the subsequent periods, which could either be the result of the 2012 reform not being completely successful, or the result of non-tax arbitrage. We therefore conclude that from a tax-revenue perspective, cum-cum is more relevant than cum-ex.

A2 DRIP

Ang et al. (2019) identify a type of non-tax related arbitrage that involves share lending around the ex-dividend date. Specifically, some companies offer Dividend Reinvestment Plans (DRIP) that allow shareholders to exchange their cash dividends for newly issued shares. The new shares are typically sold at a discount relative to the market price. This makes it attractive for investors to participate in a DRIP.[25] There is an incentive for an investor to borrow shares with a DRIP before the dividend period, as it allows the borrower to participate in the DRIP. Ang et al. (2019) show that in Australia, only DRIP-dividends see a spike in share lending, whereas this spike is absent for non-DRIP dividends. This provides strong evidence that in Australia spikes in lending around the ex-dividend date are not driven by tax arbitrage.

In our analysis, we rule out that this important confounder can explain the effect of the Danish reform because such a reform does not affect DRIP arbitrage. Therefore, if the spike in lending in Denmark is the result of DRIP rather than DWT arbitrage, it should remain in place after the reform. However, additionally in this section, we run a robustness check by focusing the analysis exclusively on events for which the public float of the company remains constant during the event window. Since a DRIP involves the issuing of new shares, we can be certain that for these dividend events no DRIP took place. The results are presented in Figure A.6. As can be seen, the results in Figure A.6 are virtually identical to our main result

[25]Sometimes the term DRIP is also used to describe an agreement between an investor and a broker to invest cash dividends into new shares. The key difference is that such an agreement with the broker does not result in newly issued shares, since the broker simply buys the shares from the market. As a result, there is also no discount relative to the market price, and no arbitrage opportunity for these DRIPs.

which includes DRIP events 5.

A3 Case Study UK

The UK does not levy a DWT. Therefore, it is at first sight puzzling that European Securities and Markets Authority (2020) reports significant spikes in stock lending around ex-dividend date. In this appendix we explain the finding by the ESMA as follows. We first estimate the excess stock lending on the ex-dividend date using our standard empirical approach (i.e. estimating regression equation (1)). Second, we estimate the same equation but drop all dividend payments involving a DRIP.[26]

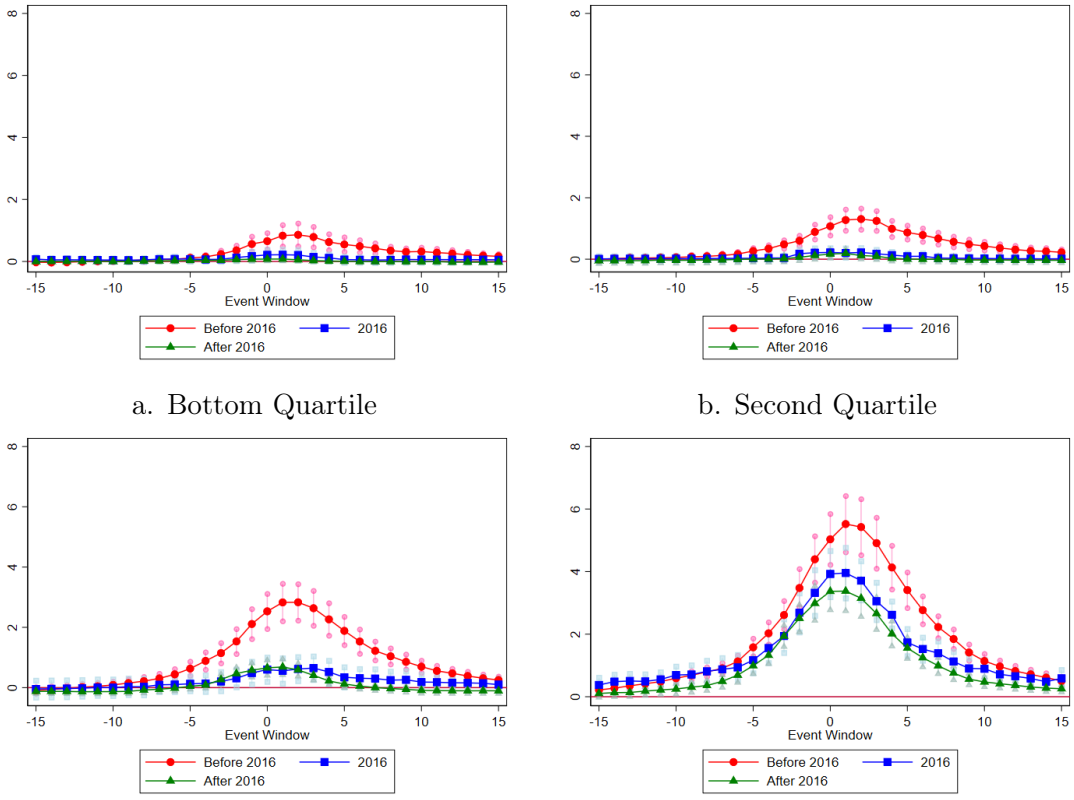
Figure A.7 plots the result for both specifications. We replicate the finding of the ESMA by showing that there is indeed a significant increase in stock lending around the ex-dividend date in the UK. However, Panel B reveals that there is no increase in stock lending in non-DRIP events. Hence, we find no evidence of DWT arbitrage in the UK, consistent with the fact that the UK does not levy a DWT. Instead, the spikes in stock lending in the UK are the result of DRIP arbitrage.

Our findings for the UK are inconsistent with our analysis for the Nordic countries in Appendix A2 where we find that DRIP and non-DRIP dividend payments result in very similar spikes in stock lending. The most likely explanation is the large role of the banking sector in the UK. Banks face strong regulations regarding the minimum amount of shareholder equity on their balance sheet. DRIPs are particularly interesting for banks, because they allow them to issue new shares at relatively low cost (see also Ang et al., 2019 for a more detailed explanation). Hence, it stands to reason that DRIPs and DRIP-arbitrage play a larger role in the UK than in the Nordic countries.

A4 Appendix Figures and Tables

[26] See Appendix A2 above for an explanation of DRIP.

Figure A.1: Heterogeneity in excess stocks on loan with respect to market capitalisation for the control group



a. Bottom Quartile

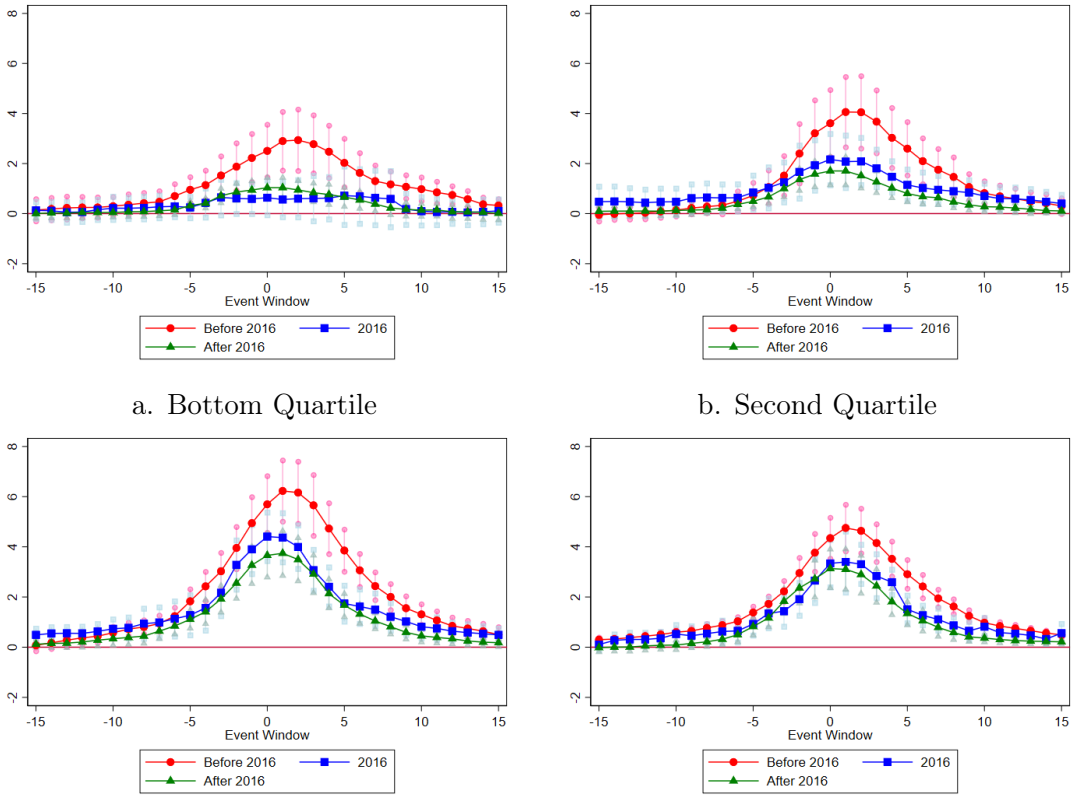
b. Second Quartile

c. Third Quartile

d. Top Quartile

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time - where $\tau = 0$ is the ex-dividend date - and by quartile of market cap. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

Figure A.2: Heterogeneity in excess stocks on loan with respect to dividend yield for the control group



a. Bottom Quartile

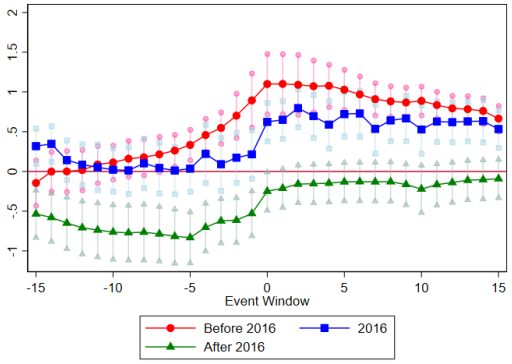
b. Second Quartile

c. Third Quartile

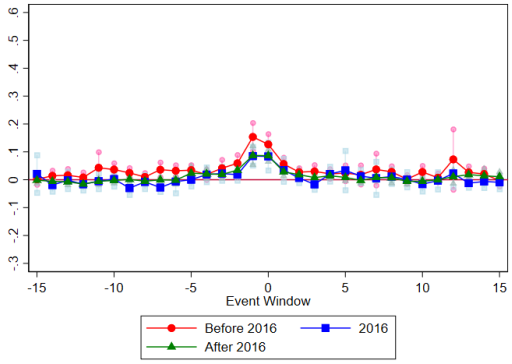
d. Top Quartile

Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time - where $\tau = 0$ is the ex-dividend date - and by quartile of dividend yield. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

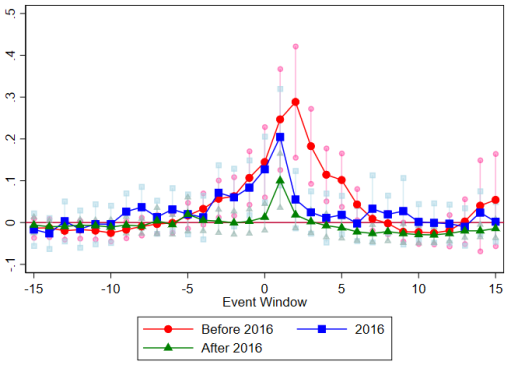
Figure A.3: Event study for additional outcome variables for the control group



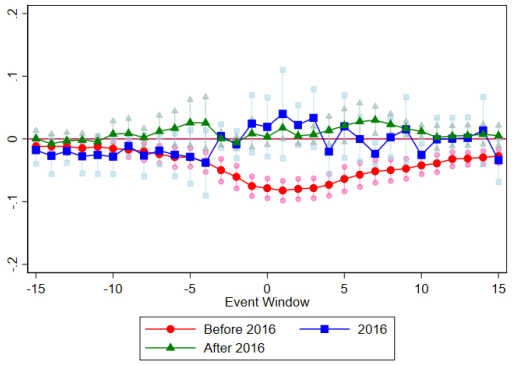
a. Quantity Available for Lending



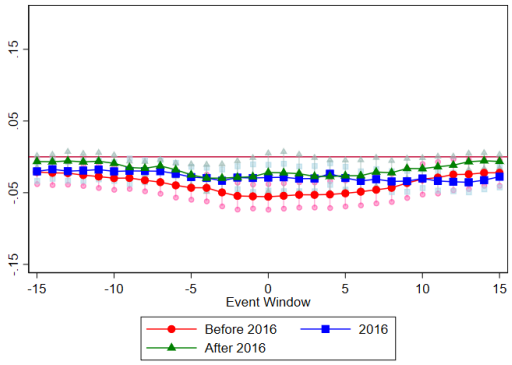
b. Turnover



c. Cost of Borrowing



d. Borrower Concentration



e. Lender Concentration

Notes: The Figure plots the outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each outcome variable is estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.

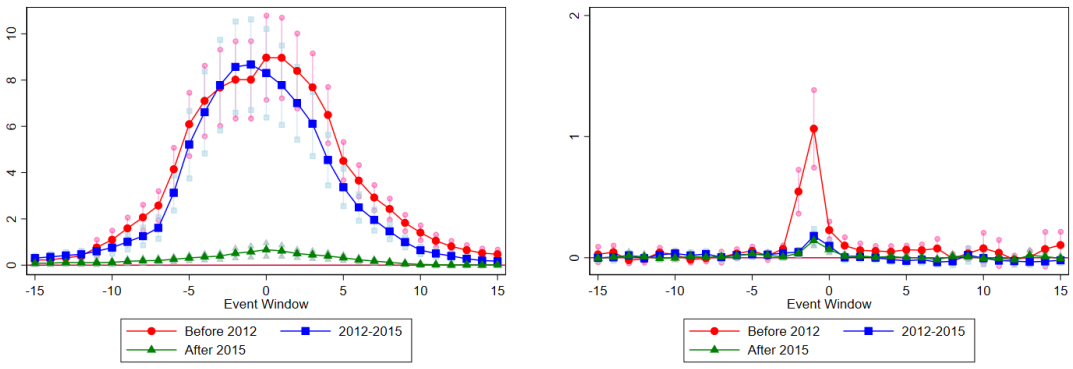
Figure A.4: Net DWT revenue and reimbursements

a. Denmark b. Finland

c. Norway d. Sweden

Notes: Plot of the amount of net DWT revenue in million of USD (left axis), and reimbursements as a percentage of gross tax revenue (right axis) by country.

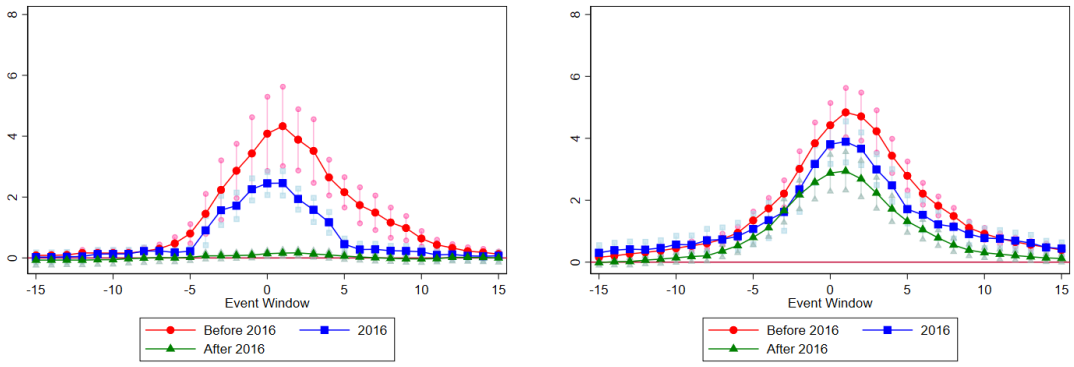
Figure A.5: Germany



a. Excess Stocks on Loan b. Turnover

Notes: The Figure plots the excess stocks on loan as a percentage of the public float and the stock market turnover as a percentage of public float by event time where $\tau = 0$ is the ex-dividend date. The excess stocks on loan and the stock market turnover are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by i.) treatment group (Germany), and ii.) period: before the 2012 reform (2010-2011), after the 2012 reform and before the 2016 reform (2012-2015) and the post-reform period (2016-2019). Standard errors are clustered at the issuing company level.

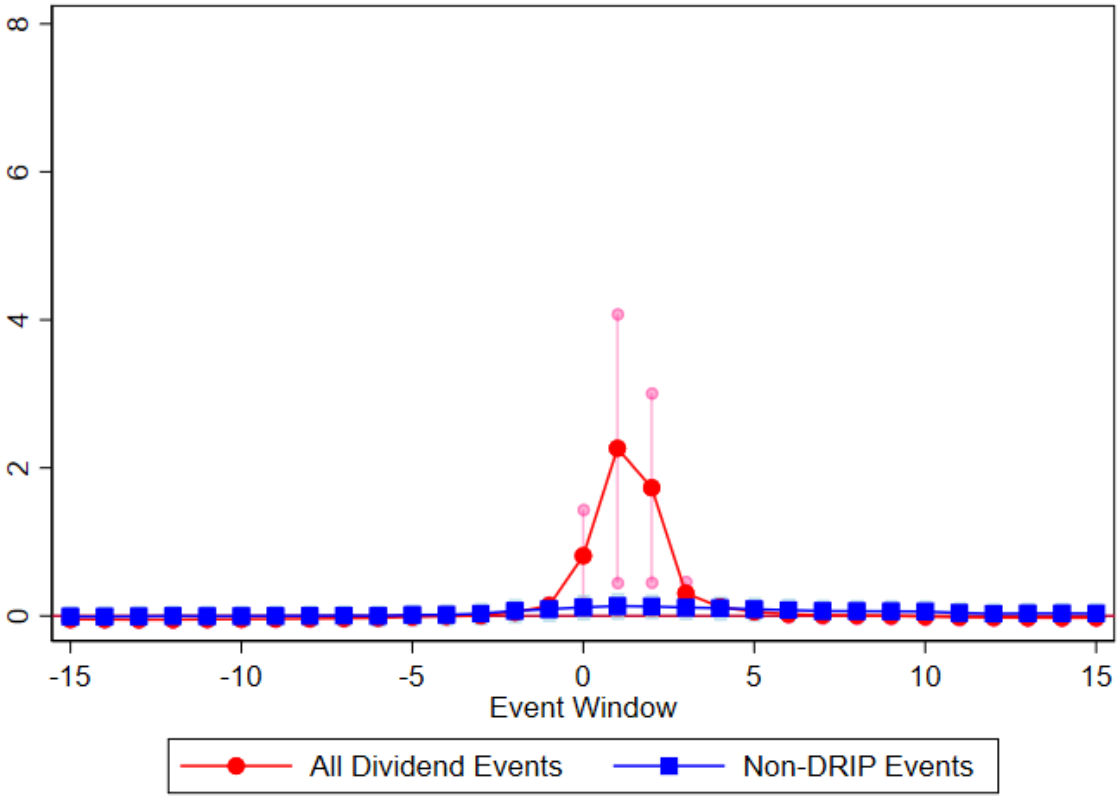
Figure A.6: Event Study Excluding Dividend Distributions with DRIP



a. Denmark b. Control Group

Notes: The Figure replicates Figures 5 on a sample that excludes DRIP-dividend distributions.

Figure A.7: UK



Notes: The Figure plots the excess stocks on loan as a percentage of the public float by event time where $\tau = 0$ is the ex-dividend date for all dividend distributions and excluding DRIP-dividend distributions. The excess stocks on loan are estimated via event study regression equation (1) which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting β_{tk} are aggregated by i.) treatment group (UK), and ii.) period: before the reform (2010-2015), the reform-year (2016) and the post-reform period (2017-2019). Standard errors are clustered at the issuing company level.