CESifo WORKING PAPERS

9594
2022

Original Version: February 2022
This Version: August 2023

# The Big Short (Interest): Closing the Loopholes in the Dividend-Withholding Tax

*Elisa Casi, Evelina Gavrilova, David Murphy, Floris Zoutman*

CESifo

## Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 9594*

# The Big Short (Interest): Closing the Loopholes in the Dividend-Withholding Tax

## Abstract

We study the effect of stricter enforcement of the dividend-withholding tax (DWT). We focus on a 2016 Danish reform and compare Denmark to its Nordic neighbors. Firms in all countries exhibit strong spikes in stocks on loan around dividend dates. These spikes comprise several percent of the public float. The spikes are consistent with the most popular DWT arbitrage transactions. Post-reform, spikes in Denmark disappear. Stricter enforcement results in an approximately 130 percent increase in annual DWT revenue. Stricter enforcement does not negatively affect the investment climate as measured through Danish stock returns, investment and dividend yield. Studying other European reforms, we find that the 2016-reform in Germany was similarly able to eliminate spikes in security lending.

JEL-Codes: K220, H260, G180, F230, M210.

Keywords: dividend tax arbitrage, tax enforcement, security lending, welfare effects.

*Elisa Casi*
*NHH Norwegian School of Economics*
*Bergen / Norway*
*elisa.casi@nhh.no*

*Evelina Gavrilova*
*NHH Norwegian School of Economics*
*Bergen / Norway*
*Evelina.Gavrilova-Zoutman@nhh.no*

*David Murphy*
*NHH Norwegian School of Economics*
*Bergen / Norway*
*david.murphy@nhh.no*

*Floris Zoutman*
*NHH Norwegian School of Economics*
*Bergen / Norway*
*floris.zoutman@nhh.no*

August 15, 2023
We would like to thank David Agrawal, Giacomo Benini, Katarzyna Bilicka, Thiess Buettner, Richard Collier, Dhammika Dharmapala, Michael Deveraux, Trond Døskeland, Ana Jorge Finnigan, Irem Guceri, Jim Hines, 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, Martin Simmler, Laurent Simula, Simone Traini, Guttorm Schjelderup, Christoph Spengel, Maximillian Todtenhaupt, Johannes Voget, and Eric Zwick for helpful comments and suggestions. We are thankful to the Norwegian Tax Authorities, Danish 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.

# 1 Introduction

It is notoriously difficult to enforce taxation on dividends of publicly traded stocks. Poterba and Summers (1984) document that dividend arbitrage transactions were already commonplace in the 1970s. Over time, some countries have attempted to increase enforcement by introducing new regulations, and by requiring additional documentation. However, little is known about whether these efforts i.) reduce the number of dividend-arbitrage transactions, ii.) result in additional tax revenue, and iii.) affect behavior of firms that rely on the stock market as a source of financing.[1] Conceptually, enforcement policy trades off tax revenue gains, against behavioral responses by firms and investors. To our knowledge, there are no studies that evaluate this trade-off empirically and study broader welfare consequences of dividend-tax *enforcement*.

We address this issue by studying a Danish reform in the dividend-withholding tax (DWT). In 2015 Danish tax authorities discovered large-scale dividend arbitrage transactions that exploit the reimbursement system for the DWT, and temporarily halted reimbursement. In 2016 the Danish tax authority resumed reimbursement with stricter documentation requirements to ensure that applicants who request a reimbursement are indeed eligible. We study the effect of this enforcement shock on DWT arbitrage, and provide a comprehensive overview of the welfare consequences.

Although our main focus is on the Danish reform, it is important to note that the abuse of the DWT reimbursement system is not limited to Denmark. Reporting in the "Cum-ex files" by the journalistic consortium CORRECTIV (2021) indicates that the type of arbitrage encountered in Denmark is commonplace in (at least) the US and Western Europe. A back-of-the envelope calculation by Endres and Spengel (2015) finds revenue losses amounting to 210 billion euros across the US and 11 Western European economies in the last two decades. In the European Parliament Spengel (2021) refers to this as the "biggest tax robbery in European History".[2] To indicate the scope, a building will be set up in Germany exclusively dedicated to cum-ex investigations and court cases, which so far includes the prosecution of 1,500 individuals and 130 financial institutions.[3]

Despite the wide-spread abuse, the DWT remains an important instrument in tax enforcement, particularly in the context of dividends that flow from developed countries to tax havens (e.g. Johannesen and Zucman, 2014; Johannesen, 2014). The European Commission has recently launched a proposal to improve the existing DWT and reimbursement systems

[1] There exists a much larger empircal and theoretical literature that studies the effect of (reforms in) dividend tax rates (e.g Chetty and Saez, 2005, 2010; Yagan, 2015; Koethenbuerger and Stimmelmayr, 2021; Becker et al., 2013; Moon, 2022; Jacob and Todtenhaupt, 2023). However, this literature typically does not consider dividend arbitrage.

[2] The transactions we study in this paper have been ruled fraudulent in some court cases (e.g. a decision in January 2020 by the Hesse Tax Court and a decision in March 2020 by the regional court of Bonn (Spengel, 2021)) However, the legality has not been decided universally which is why we apply the neutral term tax arbitrage rather than tax fraud.

[3] See https://siegburg.de/2023/06/cum-ex-gebaeude-tritt-aus-dem-boden/index.html and https://www.zeit.de/news/2023-01/04/gestohlene-milliarden-justiz-arbeitet-cum-ex-skandal-auf.

across its member states.[4] Meanwhile, the UK which abolished the DWT in 2008, has started a discussion on reintroducing it (Warburton, 2022) and Brazil which abolished the DWT in 1995, recently published a law introducing it (EY, 2021). Therefore, an important policy objective of our study is to understand whether the Danish reform can serve as a blueprint for redesigning the DWT.

Our study makes use of the fact that the most popular DWT arbitrage transactions rely on the security-lending market. These transactions are known as cum-cum and cum-ex transactions. In a cum-cum transaction a foreign investor lends their shares to a domestic institution before the dividend-record date. The different tax treatment of domestic versus foreign investors allows the foreign investor to benefit from DWT relief that would normally only be given to domestic investors. 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 across Europe as we document in this paper (see e.g. Figure 1).

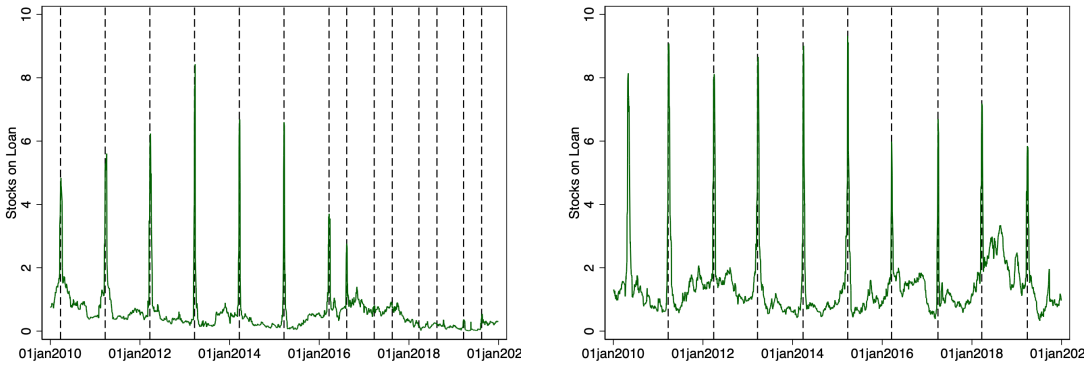
In our study, we exploit novel data on lending and tax revenue to make an accurate analysis of the size of the cum-cum and cum-ex problem and to offer a comprehensive assessment of the effect of stricter DWT enforcement on welfare. We divide the analysis in three parts. First, we consider the effect of the Danish reform on cum-cum and cum-ex transactions, as observed by the spikes in the security-lending market. Second, we explore the broader welfare consequences by studying tax revenue, stock returns, investment rate and dividend policy. Third, we zoom out from Denmark, and document i.) the extent to which cum-cum and cum-ex transactions are present in 15 Western-European economies and ii.) the effect of changes in enforcement in these countries when applicable.

In the first two parts we focus on data from the Nordic countries, namely 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. 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 reimbursements. To our knowledge DWT revenue data has never been analyzed before, and is not available for any of the other countries in our study.

The identification strategy in the first part of our analysis is based on a triple comparison. 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 Danish reform.

Figure 1 provides a raw-data example of our identification strategy. The Figure plots the

[4]For more details, `https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3301`




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 for Novo Nordisk.

stocks on loan, sometimes referred to as short interest, over time for the Danish pharmaceutical firm Novo Nordisk (panel A), and the Swedish bank Svenska Handelsbanken (panel B). Prior to the reform in 2016, both firms see abrupt spikes in lending around each dividend payment, constituting up to 8 percent of the public float. The largest spike in 2013 for Novo Nordisk corresponds to a market value of roughly 5.5 billion USD. After the reform, the spikes for Novo Nordisk disappear, but they continue for Svenska Handelsbanken. We interpret this as causal evidence that the Danish reform is successful in targeting the most common forms of cum-cum and cum-ex transactions.

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 firms was on loan in the dividend period. This spike disappears in Danish firms after the reform, but continues in Finnish, Norwegian and Swedish firms. 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]

The fact that the spike in lending disappears (almost) entirely after the reform provides new insights into the importance of tax-arbitrage vs non-tax arbitrage around dividend payments.[6] Since the Danish reform only affects tax arbitrage, we are able to isolate the tax effects in

[5]We discuss the difference in the institutional setting between the US and Europe in Section 2.3.

[6]Among the non-tax incentives Bali and Hite (1998) argue that the pricing on the ex-dividend day may be driven by discretization of the stock market prices, Frank and Jagannathan (1998) discuss micro-structure arguments that may drive investors to sell on the cum-dividend day, and to buy on the ex-dividend day, and Ang et al. (2019) suggest that investors borrow shares around the ex-dividend day in an effort to benefit from newly issued shares sold at a discount to current shareholders. We consider the latter hypothesis in more detail in our Online Appendix.

dividend arbitrage and show that non-tax arbitrage plays at best a minor role in explaining trading patterns around ex-dividend dates.

In the second part of our analysis, we focus on the welfare consequences of the reform. We first consider the effect on tax revenue. Here we rely on unique annual data on tax receipts and reimbursements in the Nordic countries. We use Syntethic DiD (Arkhangelsky et al., 2021) to compare net DWT revenue in Denmark to a weighted average of Finland, Norway and Sweden. The formal analysis estimates a causal effect of 1.3 billion USD (130 percent of pre-reform revenue). Consistent with the reform, this is primarily driven by a reduction in reimbursements. For comparison, the increase amounts to about 12 percent of corporate tax revenue Denmark collected in 2017.

Next, we consider whether the Danish reform has negative spillovers on domestic firms. Stricter enforcement of DWT can make investment in Danish companies less profitable for foreign investors. This can in turn, negatively impact the ability of Danish firms to attract capital. Therefore, a reasonable concern for policy makers is that stricter enforcement of the DWT negatively affects the investment climate in their country.

We study these spillovers using a DDD strategy which compares i.) Denmark to the other countries, ii.) before and after the reform, and iii.) strongly and weakly treated firms. Here, we use our security-lending data to create a measure of treatment intensity. Stocks which, prior to the reform, exhibited strong spikes in security lending around dividend payments are considered strongly treated, since many of their investors participated in DWT arbitrage. Stocks with smaller (or no) spikes are weakly treated. This measure differs within countries, and hence, allows us to control for shocks to treatment/control countries that are unrelated to treatment.

We first use this strategy to consider whether the initial halting of reimbursements in August 2015 has impacted stock market returns in Denmark. We find that relative to firms with low treatment intensity, firms with high treatment intensity experienced a negative abnormal return of approximately 2 percentage points in the two trading days immediately following announcement (significant at the 10 percent level). However, this effect dissipates rapidly, and cumulative abnormal returns are no longer significant 3 days after the event. When we look at the date when reimbursements were reinstated we find no significant reaction in the stock market.

Next we use annual financial statement data to assess whether the reform affects investment and dividend yield. Trends are parallel prior to the reform, and remain parallel afterwards. This indicates that the reform has not significantly affected investment or dividend yield.[7]

In the final part of our analysis, we focus on security-lending data from other European countries. We find that spikes in security lending around dividend payments are 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 an average of 10 percent

[7]These results are robust to a simpler DiD strategy, where we compare Danish firms to firms in the other three Nordic countries.

of the public float. Spikes in Southern Europe and Ireland are much smaller. 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, similar to our results for Denmark. The spikes in Austria also 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 use the UK case study to provide additional validation to our main identification strategy, since the UK does not levy a DWT.

Overall, our paper finds that dividend arbitrage in the form of cum-cum and cum-ex is a wide-spread phenomenon within Western Europe but stricter enforcement can be effective in preventing it. Although dividend-tax arbitrage is widely studied, our data enables us for the first time to our knowledge to document arbitrage of this magnitude, constituting 4 percent of the publicly-traded stock in Denmark, and up to 10 percent of publicly-traded stock in Germany, and present in virtually all countries that levy DWT. Similarly, the success of the reforms we study in Germany and Denmark is exceptional. Both eliminate arbitrage through security-lending completely. In Denmark, we see that this results in a more-than doubling of DWT revenue. We find no evidence that stricter enforcement results in a deterioration of the investment climate. Therefore, we conclude that the Danish reform in enforcement can serve as a blueprint to reforms in other countries.

*Related Literature* We are the first paper to study the welfare effect associated with stricter dividend-tax enforcement. In doing so, our paper bridges the gap between the literature that studies the impact of stricter dividend tax enforcement (Lakonishok and Vermaelen, 1983; Poterba and Summers, 1984; McDonald, 2001; Dixon et al., 2021) on financial trading patterns, and the literature that studies the welfare impact of variation in the dividend-tax rate (e.g. Chetty and Saez, 2005; Auerbach and Hassett, 2006; Brown et al., 2007; Blouin et al., 2011; Becker et al., 2013; Yagan, 2015; Alstadsæter et al., 2017; Bach et al., 2019; Moon, 2022). Thereby, we contribute to a better understanding of the desirability of strict tax enforcement in the context of an elastic tax base, and with potential spillover effects to the corporate sector.

Buettner et al. (2019) study a reform targeted against cum-ex trading in Germany. Relative to this analysis we contribute by using security-lending data which allows us to document DWT arbitrage activity that is larger by an order of magnitude, and correspondingly, larger reform effects. Additionally, we are the first paper to quantify the welfare effects associated with stricter enforcement. Finally, we analyze tax arbitrage across 15 European economies.

In addition, the results of our paper are relevant to the literature investigating the effect of stricter enforcement on tax compliance (e.g. Kleven et al., 2011; Kopczuk et al., 2016; Almunia and Lopez-Rodriguez, 2018).[8] We contribute by not only offering evidence on the direct consequence of stricter enforcement on taxpayer compliance, but also examining broader economic consequences of stricter enforcement on firms and investors..

[8]See Slemrod (2019) for a survey of the literature.

The rest of the paper is organized as follows. Section 2 provides institutional background on DWT, cum-cum, cum-ex transactions and the countermeasures introduced by Denmark. 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

In most developed countries dividend payments from corporations give rise to tax liabilities within the source country via a DWT.[9] When a firm distributes dividends, it withholds the DWT and it remits the tax directly to the respective tax authority of the home source country. 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, Desai and Dharmapala, 2011). 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.[10] The DWT weights particularly heavily 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 are several obstacles to taking advantage of these bilateral double tax agreements: i) there is a high compliance cost for claiming foreign tax credits; ii) not every country has signed such a bilateral double tax agreement; iii) not every investor is subject to taxation in their residence country (Jacob and Todtenhaupt, 2023).

DWT arbitrage strategies have been designed to permit investors to remove such costs or even to exploit the system to turn the 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 the 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 Figure 3 we illustrate a typical cum-cum transaction. In this transaction, the owner transfers the shares with attached dividend rights just before the dividend record date to an acquirer. The acquirer, typically a financial intermediary, is a resident in the same country as the corporation paying the dividend and she/he is typically exempt from the DWT by being

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

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

a domestic investor. Shortly after the dividend record date, the shares are returned to the original owner together with a security lending fee to compensate the owner for the dividend payment. Importantly, the security lending fee is not treated as income and thus it is not subject to tax. In this way, a cum-cum transaction enables the owner of the shares to avoid the DWT by exploiting the different tax treatment for capital income of resident taxpayers and non-resident taxpayers.[11] Meanwhile, as illustrated in Figure 4, in a cum-ex transaction, shares are sold short just before the dividend record and thus with dividend rights, but the delivery of the shares occurs just 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. Within this time-lag several investors can exchange the stock as illustrated in Figure 4. Around the dividend payment date, several parties claim ownership of the shares to the tax authorities, including the short buyer and the original owner of the shares. In this way, a cum-ex transaction leads to multiple refunds of a tax where there should be only one refund.[12]

Both cum-cum and cum-ex transactions are reflected in the stocks on loan variable. In a cum-cum transaction, the transfer of the share around the ex-dividend day is recorded as a loan of the stock. Similarly, in a cum-ex transaction, the short-seller is required to borrow the share for delivery to the buyer.[13]

## 2.2 Danish Reform: Increasing Ownership Information as a Countermeasure

In recent years several EU countries have legislated reforms to curb DWT arbitrage strategies. We mainly focus on a reform in Denmark (see Figure 2 for a timeline). When the Danish tax authorities became aware of large-scale DWT arbitrage, they temporarily halted all refunds on August 6, 2015.[14] The tax authority launched an action plan to improve the administration of the DWT refund in the Fall of 2015.[15] This resulted in an administrative change which became effective on March 17, 2016 and abolished the possibility to apply for a tax refund at source.[16] Instead, dividend income is distributed net of the DWT and a tax refund can be

[11] In the Appendix, we provide an example to clarify the mechanism of a cum-cum transaction. For a detailed explanation of cum-cum transactions, see also Spengel (2016).

[12] In the Appendix, we provide an example to clarify the mechanism of a cum-ex transaction. For a detailed explanation of cum-ex transactions, see also Collier (2020).

[13] There are also cum-cum transactions that do not exploit the security-lending market such as sale- and repurchase agreements that transfer the stocks to a tax-advantaged party. In our financial-market analysis we also consider regular turnover on the stock exchange around the ex-dividend date as an outcome variable. In addition, in our welfare analyis we consider DWT revenue, which aggregates the impact of all tax-arbitrage transactions.

[14] For more information, see the letter to the Danish ministry of taxation from the Danish tax authorities, available at `https://www.ft.dk/samling/20181/almdel/sau/spm/117/svar/1544199/1994215/index.htm`

[15] See the report called "SKAT ud af krisen" published by the Ministry of Taxation on September 25, available here `https://www.skm.dk/aktuelt/publikationer/politiske-udspil-og-aftaler/skat-ud-af-krisen/`

[16] See the information published by the Danish tax authorities here `https://web.archive.org/web/20200923103244/https://skat.dk/skat.aspx?oid=2244412`. The exact dates have been also confirmed by the Danish tax authorities when contacted by us.

subsequently requested upon the submission of relevant documentation. The most significant documentation requirement includes evidence of beneficial ownership of the shares, as only the beneficial owner can receive a tax refund. If the shares are involved in a short-term share-lending agreement, then the lender (and only the lender) of the shares will be recognized as the beneficial owner. As a result, in a short-term share-lending agreement, the borrower cannot claim to be the owner of the stocks and, as such, an integral step of the cum-cum and cum-ex strategies is no longer effective.

The Danish reform 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- (in France and Germany) or 60- (in Belgium)-day window around the dividend payment. While this legislation should bring a halt to DWT arbitrage in a similar way to the Danish reform, it also potentially increases the cost of non-tax arbitrage around the dividend day as the investor needs to hold on to the stock for a set amount of days in order to receive reimbursement. Conversely, in Denmark, for short-term loans, the lender of the stock remains eligible for reimbursement, and hence, any non-tax arbitrage transaction remains profitable after the reform. Therefore, the reform in Denmark impedes DWT arbitrage without affecting other forms of dividend arbitrage. This feature allows for a clean identification of the effect of halting DWT arbitrage. We describe the non-Nordic reforms in more detail in section 6.1.

Consistent with the timeline, we divide the sample in three periods in our empirical analysis. First, the pre-reform period ranges from the beginning of our sample period to August 6 2015 when payments were temporarily halted. During the pre-reform period there were few restrictions on dividend-arbitrage in Denmark. Second, the reform period which ranges from August 6 2015 to July 1 2016. July 1 is chosen since it signifies the unofficial end of the major dividend season in the Nordics, which are typically distributed in spring. The reform period signifies a period of some uncertainty to investors, since before March 17 2016 they were unaware what the new DWT regime would look like, and in the period from March 17-July 1 2016, some investors may not have been fully aware of the impact of the reform. Finally, we consider the post-reform period from July 2016 onward, in which the vast majority of investors are informed about the impact of the new rules. When we work with annual data, we consider 2014 as our base year since it is the last year not affected by the reform. In annual data we expect to see the strongest effects from 2016 onwards, since 2015 is only partially treated.

### 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: i.) the holding period which is present in the US, but absent in the Nordics; and ii.) 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 introduces a reduced DWT rate of 15% for qualified dividends, i.e. those paid by US firms 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 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 previously (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 the supply for lending to remain constant, or even increase during the dividend period, both before and after the Danish reform. We explore this hypothesis in more detail in section 4.2.

# 3 Data

For our analysis, we collect three type of data: daily financial market data which we use for our analysis on financial-market responses to the reform in Denmark, annual country-level data which we use to study the impact of the reform on tax revenue, and finally annual firm-level data which we use to study the impact of the reform on investment and dividend policy. Below we provide a description of each data source, and how we combine them into our analysis.

## 3.1 Daily Financial Market Data

Our data on security lending comes from S & P Global (formerly IHS Markit, and henceforth referred to as Markit) which collects data on security lending and borrowing from over-the-counter (OTC) transactions. Markit has virtually universal coverage of share-lending transactions in developed countries. 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 firm name. This allows us to match 96% of the Markit data to Compustat Global.

Our unit of analysis is the security, since we keep secondary stocks in the event where a firm issues two different types of stocks. However, we drop all secondary listings in case the same security is listed on two different stock exchanges.

Table 2 provides summary statistics for the four Nordic countries, before and after the Danish reform, and inside and outside of the event window around dividend payment. 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, 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), iv.) and v.) Herfindahl Indices for lender and borrower concentration, respectively.

### 3.2 Annual Country and Firm-level Data

For our analysis on the welfare consequences we also collect annual data on DWT revenue, the investment rate, and dividend yield. First we use annual country-level data on DWT revenue data. The 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/or reimbursements available.

Similar to 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 i.) by using net DWT revenue rather than reimbursements as our main outcome variable and ii.) by averaging over multiple years when we estimate the causal effect. This attenuates short-term noise related to cash-flow accounting.

Second, we use annual firm level data on investment rate and dividend policy by merging data from Compustat Fundamentals with our financial data. Our two main variables of interest are the investment rate of firms, and the dividend yield of firms. Following previous literature (e.g. Maffini et al., 2019; Ohrn, 2018; Edgerton, 2010), we define the investment rate as the ratio of current capital expenditures to fixed assets at the beginning of the period. To calculate dividend yield we take our daily data and collapse it to the annual level. Dividend yield is then calculated as the total annual dividend divided by the mean stock price during the

year. This approach allows us to combine data from firms that have an annual dividend, with firms that distribute dividends on a more frequent basis. Both dividend yield and investment are winsorized to reduce the impact of outliers. Summary statistics for our annual data are reported in Table 3.

# 4 The Effect of the Danish Reform on Cum-cum and Cum-ex Transactions

## 4.1 Identification Strategy

The first part of our analysis focuses on whether the Danish reform targeted at 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 $\tau$ denotes event time. We consider a 31-day window centered around the ex-dividend date and we keep observations from outside of the event window as the omitted category in our analysis.

We estimate the following equation for each country:

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

where our primary outcome variable $y_{it\tau}$ is the stocks on loan as a percentage of the public float, $I(t \in k)$ is a dummy that takes value 1 if date $t$ is in year $k$. Our coefficient of interest $\beta_{\tau k}$ measures the excess stocks on loan on event day $\tau$ in year $k$. Given that DWT arbitrage schemes are reflected in the number of stocks on loan, we expect that $\beta_{\tau k} > 0$ for event dates $\tau$ close to the ex-dividend date, and in years prior to the reform.

$\eta_{ik}$ represents security-year fixed effects which are identified by observations outside of the event window. $\eta_{ik}$ controls for the regular amount of lending a stock would typically have in year $k$. Here, and throughout the remainder of the paper we use weighted least squares, where the average market value of the securities 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 firm level.

## 4.2 Main Results

Figure 5 provides the coefficients $\beta_{\tau k}$ for Denmark (panel A), Finland (Panel B), Norway (panel C) and Sweden (Panel D) 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 in all countries. Loans typically spike 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 reaches a peak on the dividend record date, consistent with the findings of Dixon et al. (2021) for the US.

The spikes range between 3 and 6 percent of the public float, with, typically, slightly more lending in Sweden than in the other countries. After 2016, the evidence for excess lending in Denmark disappears, whereas a spike in lending remains present in the other countries. This is consistent with a causal effect of the reform.

Figure 6 plots the coefficients from Figure 5 aggregated by the pre-reform, the reform period, and the post-reform period. 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 around dividend events. After the reform, the spike in Denmark all but disappears. In the control group, the spike also reduces somewhat. A possible explanation for this reduction is that some investors were worried about legal repercussions related to court cases in Germany.[17] Nevertheless, it is clear that Denmark is the only country for which the spike in lending completely disappears.

With respect to timing of the effect, it is interesting to observe that the largest reduction in the spike occurred after the reform was enacted, rather than during the reform period. This indicates that many investors continued pursuing their dividend-arbitrage strategy until it became absolutely clear that the strategy was no longer profitable, even though reimbursements had already temporarily been halted since August 2015.

Figures 5 and 6 provide strong evidence that the spike in lending is causally related to DWT arbitrage, rather than other types of arbitrage. As discussed in more detail in section 2, the Danish reform only affected enforcement of the DWT, leaving the profitability of other potential arbitrage mechanisms in place. After the reform, the spike in lending disappears entirely, which implies that the spike must have been the result of DWT arbitrage. Nevertheless, in the Online Appendix we provide an additional robustness check, by explicitly considering the only other type of arbitrage suggested in the literature that may cause spikes in lending based on Ang et al. (2019). This robustness check also verifies that the spikes we find are causally related to DWT arbitrage, rather than to other arbitrage strategies.

The magnitude of the effect we find is large. Prior to August 2015 the average spike in excess stocks on loan in Denmark is around 4 percentage points of the public float. Outside of the event window, the average stocks on loan represent 1.3 percent of the public float (see Table 2). Therefore, the spike represents a $4/1.3 \approx 300$ percent increase in loans relative to regular trading days. For comparison, in the US Dixon et al. (2021) find that excess stocks on loan spikes by 0.6 percent point of the public float on the dividend-record day. Thus the spike 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.

[17] In August 2015, the German Federal Tax Court denied reimbursement for the DWT in a cum-cum transaction. This is the first court case on cum-cum transaction, see Junge and Kleutgens (2016).

### 4.2.1 Heterogeneity

We consider heterogeneity in the effect size by market capitalization and dividend yield. Intuitively, since larger firms are more likely to be included in the portfolio of international investors, we expect a stronger effect for larger firms. 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 7 and Figure 8 and offer the same graphical evidence for Finland, Norway and Sweden in the Online Appendix (Figures A.1, A.2).

Figure 7 shows results by quartiles of market capitalization. The evidence for the highest quartile is consistent with our hypothesis that DWT is most prominent for the largest firms. Specifically, the spikes are not significant for the first quartile, and increase monotonically with the market capitalization of the underlying firm.

However, in Figure 8, we find no clear pattern with respect to dividend yield. This finding is consistent with anecdotal evidence that investors engage in several cum-cum and cum-ex transactions at the same time, making the overall profits from DWT arbitrage high despite a relatively small gain from each single transaction (see for instance reporting in the New York Times by Segal, 2020).

## 4.3 Additional outcome variables

We estimate equation (1) on a number of additional outcome variables from our dataset. The purpose is to compare our results to the literature, (e.g. Thornock, 2013; Buettner et al., 2019; Dixon et al., 2021), and to gain a deeper understanding for the security-lending market around dividend payment. Figure 9 displays results for Denmark. Results for the control group can be found in the Online Appendix Figure A.3.

*Stocks available for lending.* 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. Thornock (2013) and Dixon et al. (2021) find that in the US stocks available for lending reduce significantly around the ex-dividend day. However, Nordic tax systems provide different incentives with respect to the US as detailed in Section 2.3, thus we expect that in the Nordic countries the supply for stocks does not drop. In Figure 9 panel A we present results on stocks avaiable for lending as an outcome variable. The results are consistent with the hypothesis that the supply of stocks does not systematically change or decrease around the dividend days. If anything, Danish stocks available for lending are slightly above normal in the event window prior to the reform. This elevation may be the result of additional long-term investors offering their stocks for loan to profit from a cum-cum or cum-ex transaction. After the reform, the quantity available for lending is no longer elevated.

*Cost of Borrowing.* In a security-lending agreement, the cost of borrowing represents the profit of the lender. If in the pre-reform period the cost of borrowing remains constant, this implies that the rents of cum-cum and cum-ex mainly remain with the borrower, typically a

financial intermediary, rather than with portfolio investor that offers their stocks for lending. An increase in the cost of borrowing instead indicates that the rents associated with cum-cum and cum-ex are shared.

Using Markit's 10-point scale for the borrowing fee as a measure, we do not find that the cost of borrowing is elevated around the ex-dividend day, either before or after the reform. In Figure 9 panel B, most coefficients are not significantly different from zero during our event window. This result indicates that a large share of the rents of cum-cum and cum-ex appears to accrue with financial intermediaries, rather than with portfolio investors. A potential explanation is that the market for security lending is typically slack. In the Nordic countries on average between 10-17 percent of stocks are available for lending (see row 2 of Table 2). Hence, even though the observed spikes in stocks on loan are substantial, the borrower continues to enjoy an advantageous bargaining position.

*Turnover.* In Figure 9 panel C, we consider whether stock market turnover in Denmark is elevated during the dividend period. We document three findings. First, we find evidence that turnover is slightly elevated in the control group, but not in Denmark. However, the major takeaway when comparing Figure 6 to Figures 9,A.3 panel C is in the scale. Excess turnover concerns, at most, 0.2 percent of the public float. Excess lending is at least one order of magnitude larger. We conclude that DWT arbitrage is more clearly observed in the lending market than in the regular stock market.

Second, one concern is that market participants may have responded to the reform by substituting from lending out stocks to selling and repurchasing stocks around the ex-dividend date. This would imply an increase in the turnover in the post-reform period around the dividend dates. We find little evidence for such a substitution in strategy.

Third, the reform appears to have eliminated all excess lending and trading around the ex-dividend date. Hence, non-tax arbitrage schemes, such as the ones suggested in Bali and Hite (1998); Frank and Jagannathan (1998); Ang et al. (2019) do not appear to play a major role for Danish stocks.

*Market Concentration.* Finally, in panel D and E of Figure 9, 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 in the event window, indicating that there are more active players in the lending market during dividend payments, than on regular days. In the post-reform period, excess lender and borrower concentration is non-significant during the event window, consistent with a reform effect.

# 5 Welfare Consequences of the Danish Reform

In this section, we study the welfare consequences of the reform. Our empirical analysis is roughly informed by the literature on optimal tax enforcement (e.g. Keen and Slemrod, 2017) and the literature on investment effects of the DWT (e.g. Desai and Dharmapala, 2011). Specifically, Keen and Slemrod (2017) build a model for optimal tax enforcement. In their model, the elasticity of tax revenue with respect to tax enforcement is a sufficient statistic for the behavioral responses related to enforcement. We estimate the discrete version of this elasticity: the change in tax revenue with respect to the reform.

However, relative to Keen and Slemrod (2017), an important difference in our setting is the existence of potential spillover effects. Stricter enforcement of the DWT on foreign investors, may affect the cost of capital for Danish corporations and thus trigger firm responses to the reform. To see this, note that foreign investors can use dividend arbitrage, primarily cum-cum, in an effort to avoid the DWT. Stricter enforcement therefore potentially increases the effective DWT rate in Denmark. As a result, foreign investors may decide to move their capital to other countries. This in turn can affect the cost of capital for Danish corporations. This argument closely mirrors Desai and Dharmapala (2011) who argue that changes in the DWT rate positively affect the cost of capital, though we study a reform in enforcement, rather than a reform in the tax rate.

If stricter enforcement indeed elicits a negative response by foreign investors we would expect to observe a drop in Danish stock market prices around the announcement of the reform. In addition, we might observe a reduction in investment for those firms whose cost of capital has been affected. Finally, Danish firms may alter their payout policy, substituting away from dividends when DWT is enforced more strictly.

## 5.1 Tax Revenue

We first consider the effect of the reform on net DWT revenue. Intuitively, the reform provides identification through a DiD variation, as it affects Denmark but not the other 3 Nordic countries.

We employ synthetic DiD (Arkhangelsky et al., 2021). Synthetic DiD has two advantages over regular regression approaches in this setting. 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).[18]

Figure 10 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

[18]Here for inference we apply the "placebo" method, which simulates placebo-treatments by counterfactually assigning treatment status to one of the control countries. This procedure provides an estimate of the variability of the treatment effect under the null hypothesis that the treatment effect equals zero. We use this as a means of quantifying the standard error around our central estimate (see Arkhangelsky et al., 2021 for more details).

up to 2014 trends between Denmark and synthetic Denmark are parallel. In 2015 there is a slight uptick in Danish DWT revenue relative to synthetic Denmark, consistent with the government temporarily halting reimbursement in August of that year. After the reform, the trends strongly diverge. In column 1 of Table 4 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. This analysis indicates that most of the increase in net DWT revenue in Denmark between 2014-2017 is causally related to the reform.[19]

To better understand the mechanism Figure A.4 in the Online Appendix 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.

## 5.2 Investor and Firm Responses

We proceed by analysing whether the reform has affected the cost of capital of Danish corporations by looking at stock market reactions around the key dates of the reform. In our identification strategy, we exploit a triple comparison, where we take the differences in outcomes of i) Danish firms relative to firms in the other Nordic Countries, ii) in the period before the reform versus the period after the reform, and iii) firms with higher treatment intensity versus firms with low treatment intensity. We base our measure of treatment intensity on the prevalence of dividend arbitrage in a firm's stock prior to the reform. Relative to a DiD approach, our treatment intensity measure allows us to control for shocks that only occur in a subgroup of the Nordic countries, and that may otherwise confound the treatment effect. Below we first outline the methodology in more detail before turning to results and discussion.

### 5.2.1 Methodology

We generate treatment intensity using the intuition that firms whose stocks on loan, prior to reform, exhibited stronger spikes around the ex-dividend date are more strongly affected by the reform. Large spikes indicate that the investors of the firm are strongly involved in DWT arbitrage. Hence, such firms are more strongly affected by the DWT enforcement, than firms whose stocks only exhibit small spikes around dividend events.

To estimate the size of the spike by firm we employ the following regression model on our security-lending data:

$$y_{ictk} = \alpha_{ick} + \beta_{ic} D_{ict} + \epsilon_{ictk}, \tag{2}$$

where $y_{ictk}$ denotes stocks on loan as a percentage of the public float for firm $i$ listed in country

[19] Note that the result is not driven by swings in the exchange rate. In the period between 2014-2017 the Danish Kroner depreciated slightly vis-a-vis the US dollar, which mechanically reduces tax revenue expressed in USD.

$c$ on day $t$ in year $k$, and $D_{ict}$ is a dummy that takes value 1 in the $[-1, 1]$ event-window around the ex-dividend date. $\beta_{ic}$ measures the increase in stocks on loan within this window relative to regular trading days. To estimate (2) we rely on our security-lending data prior to the Danish reform. We exclude observations in the $[-15, -2]$ and $[2, 15]$ windows since these may confound the estimate for the $\beta_{ic}$ in the case where the spike builds gradually. We use the estimated values of $\hat{\beta}_{ic}$ to generate a treatment intensity measure. We consider firm $i$ strongly treated if $\hat{\beta}_{ic}$ is above the median in its respective country. Formally:

$$Intensity_i = 1 \quad \text{if} \quad \hat{\beta}_{ic} > \hat{\beta}_{c,p50} \tag{3}$$

where $\hat{\beta}_{c,p50}$ denotes the median value of $\hat{\beta}_{ic}$ in country $c$. We rely on a discrete version of treatment intensity, $Intensity_i$, rather than the continuous measure $\hat{\beta}_{ic}$ to reduce the impact of outliers.

Our analysis on treatment heterogeneity in Figure 7 indicates that spikes are considerably larger for larger corporations, which could potentially introduce confounding variation. Therefore, we include non-parametric controls for both the size of the firm prior to reform, and the sector in which the firm is active. This ensures that identification comes from comparing firms of a similar size within the same sector.

We employ our treatment intensity measure to estimate the causal effect of the reform on abnormal stock returns around events dates associated with the reform. To estimate abnormal returns to Danish stocks we estimate a CAPM-model in which we relate the return to Danish stocks to the return on an index of Nordic stocks outside of Denmark. We generate the Nordic Index by taking the market-value weighted average return of all stocks in our Nordic sample outside Denmark. Note that excluding Denmark from the index is essential since in principle, all Danish firms could be affected by the reform. Formally, we estimate the following CAPM-regression model:

$$R_{it} = \alpha_i + \beta_i R_t^I + \epsilon_{it}, \tag{4}$$

where $R_{it}$ denotes the return on (Danish) stock $i$ at day $t$, and $R_t^I$ denotes the return on the index. We estimate (4) on a 100-day window which ends 15 trading days before our first event on August 6 2015. We use (4) to predict 3-day cumulative abnormal returns during the events of interest. For each event date we create an event window with event-time $\tau \in [-15, 15]$ and estimate:

$$CAR_{i\tau} = \beta_\tau Intensity_i + \gamma_\tau X_i + \nu_{i\tau}, \tag{5}$$

where $CAR_{i\tau}$ denotes the 3-day cumulative abnormal return and $X_i$ is a vector of control variables, which includes dummies for the Fama-French 12 industry classification, and the quartile of firm size measured by market capitalization. Note that $\gamma_\tau$ is allowed to vary with time, such that identification is driven by firms that are i.) within the same sector, and ii.) of similar size, but that nevertheless differ in treatment intensity.

We also use our treatment intensity measure to estimate the causal effect of the reform on

dividend yield and investment. Here we employ annual financial statement data and the DDD identification strategy. Our regression equation takes the following form:

$$y_{ick} = \beta_k Intensity_i Denmark_c + \alpha_i + \gamma_k X_i + \nu_{ick}, \tag{6}$$

where $y_{ick}$ is the outcome variable of firm $i$ in country $c$ and year $k$, $Denmark_i$ is a dummy that takes value 1 for Denmark, and $X_i$ is a vector of control variables that includes dummies for country, treatment intensity $Intensity_i$, size quartile measured by market capitalization, and Fama-French sector. Identification comes through the comparison of firms with different treatment intensity in Denmark, vs the other countries conditional on size and sector. As a robustness test, we also use a simpler DiD specification which omits the dummy variable for treatment intensity, and the country-time fixed effects. Estimates in this specification are identified through a comparison between countries. As our outcome variables we consider i.) the investment rate measured as the ratio of current capital expenditures to fixed assets at the beginning of the period and ii.) dividend yield as the total annual dividend relative to the mean stock price during the year.

### 5.2.2 Results

Results on stock market returns are presented in Figure 11. We observe a negative abnormal stock market return for strongly treated firms following the halting of DWT reimbursements on August 6th. Cumulative abnormal returns reach a minimum value of around -2.5 percent 2 days after the announcement, though the drop is only significant at the 10-percent level. However, the stock market drop is temporary in nature. 3 days after the event, the 3-day cumulative returns are no longer significantly different from zero.[20]

We find no stock response following the announcement on March 17th. There are two potential explanations. First, on March 17th the Danish tax authorities restarted reimbursements, which is positive news to investors, but at the same time announced stricter enforcement which may have been perceived as negative news. Hence, it is possible that the positive and negative effect canceled out. Second, it is likely that prior to the announcement on March 17th the market already formed expectations regarding a new DWT enforcement regime. In that case, the lack of a stock-market reaction may simply imply that the announcement was in line with the market's expectation.

Results on investment and dividend policy are presented in Figure 12. Panel A provides estimates of the effect of the reform on investment. The DDD specification shows no evidence of pre-trends, and additionally does not uncover a significant reform-effect. In the DiD specification there appears to be a slight downward pre-trend, in the sense that coefficients in the period 2010-2013 monotonically decline, though the coefficients are not significant. Despite

[20] We have also attempted a specification which ignores treatment intensity, instead relying on comparing the stock returns in Denmark vis-a-vis other Nordics. However, these results (available on request) exhibit strong pre-trends.

the downward trend, also in this specification we do not find a significant (negative) effect of the reform on investment. [21]

Panel B of Figure 12 considers the effect of the reform on dividend yield of Danish companies. We find no evidence of pre-trends. In addition, neither the DDD specification, nor the DiD specification find evidence of a significant effect of the reform on dividends.

### 5.3 Discussion

Overall, our empirical analysis indicates that the enforcement shock in Denmark strongly increases tax revenue. We find some evidence of a negative stock market response for firms whose investors are most strongly affected by the reform, but the negative effect is short-lived and can no longer be observed in the 3-day CAR 3 days after the event. We also find no evidence that the reform depressed investment and/or dividend yields of listed firms in Denmark.

We are the first to access tax revenue data on DWT. Our results indicate that the reform has substantially contributed to Danish tax revenue. For comparison, according to our central estimate the annual increase in DWT revenue equals around 12 percent of Danish corporate tax revenue in 2017[22]

In the context of the model on optimal enforcement by Keen and Slemrod (2017) the strong increase in revenue indicates that the reform increased compliance, without eliciting strong real responses in foreign investment and dividend policy that would have otherwise eroded the tax base of the DWT.

A worry that governments may have when considering stricter enforcement of DWT is that it reduces the incentive for foreign investment into Denmark, which in turn may negatively affect Danish firms. Our study finds no evidence that enforcement negatively impacts firms apart from a very short-lived reduction in stock market returns.

We are the first paper to consider the effect of dividend-tax enforcement on firm-level outcomes. hence a direct comparison with previous literature is not possible. Instead, we offer a comprehensive discussion of how our results relate to previous literature, which considers variation in the DWT rate. With respect to stock market returns, Auerbach and Hassett (2006), Brown et al. (2007) and Isakov et al. (2021), find that dividend-tax reductions are associated with positive abnormal returns. This is consistent with our finding that stricter DWT enforcement results in negative abnormal returns, although the effect in our case is short lived.

With respect to investment, Yagan (2015) and Bach et al. (2019) find no relationship between dividend tax rates and real investment for the US and France respectively. Contrary,

[21] In panel A of Figure A.5 we compare the DiD-specification which controls for sector and firms size to a specification without controls. The control variables reduce the downwards pre-trend. This is mainly driven by differences in investment between sectors, which correlates to treatment assignment. Nevertheless, we fail to uncover a negative effect of the reform on investment across specifications.

[22] See OECD (2020) for data on corporate tax revenue in Denmark.

on a sample of international firms Becker et al. (2013) find that changes in dividend tax rates are negatively associated with investment among firms that are likely to use equity as a source of investment. Similar to Yagan (2015) and Bach et al. (2019) we do not find a relationship between stricter DWT enforcement and investment. However, it is important to note that we focus on dividend-paying firms, which are more likely to have sufficient internal funds to finance their capital investment. In addition the treatment period from 2015-2019 is characterized by low interest rates, and easily accessible debt funding. This implies that the firms in our sample are unlikely to finance investment by issuing new equity. Hence, our findings are in line with the "new view" of dividend taxation, which states that investment should not depend on dividend taxation for companies that do not rely on equity as a source of funding (Auerbach, 1979; Chetty and Saez, 2010; Koethenbuerger and Stimmelmayr, 2021).

With respect to our result on dividend yield, a recent survey by Farre-Mensa et al. (2014) concludes that the effect of taxes on dividend payouts is mixed. For instance, Chetty and Saez (2005) study the effect of the US Jobs and Growth Act of 2003, which strongly reduces the dividend-tax rate. They document a strong increase in dividend payout associated with the reform. However, exploiting the same reform Brav et al. (2008) and Edgerton (2013) find little evidence that the increase in dividends payout causally relates to the tax cut. More broadly, our results are consistent with the findings in a survey of CEOs that concludes investor-level taxation only plays a secondary role in determining payout policy (Brav et al., 2005).

# 6 Results from other European Countries

In this section, we explore DWT arbitrage and reforms in the remainder of Europe.[23] 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 set introduces additional documentation, which directly targets the loopholes exploited by cum-ex transactions. The second set 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.[24]

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

[23] We exclusively focus on those reforms that have been enacted with the explicit goal of ensuring stricter enforcement of the DWT. With a different aim, Finland in 2021 and Norway in 2019 introduced a reform designed to develop a more efficient system for the DWT refunds. Although the two systems have certain differences, the overall objective is to standardize the DWT system by increasing the due diligence requirements for the dividend paying firm or authorized intermediary.

[24] The reform in Denmark we have discussed thus 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.

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.[25] 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 offices, safeguarding against the possibility that one DWT payment is reimbursed twice.[26] Austria introduced a requirement for the submission of an electronic pre-application for obtaining the refund from a DWT.[27] Specifically, until December 31, 2018, foreign investors could request a 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 a 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.[28]

### 6.2 Results

Figure 13 shows the size of the effect on the ex-dividend day for the excess stocks on loan for 15 European countries for 4 years.[29] The most noticeable change occurs in Germany, which prior to its 2016 reform had the 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 13 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, around 2015 targeted tax audits and tax court rulings in Germany 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. As a result, investors may have become more reluctant

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

[26] 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.

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

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

[29] 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 $[-3, 3]$ event window.

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 the Online Appendix Figure A.8, we show first that the spike in the stocks on loan in the UK are driven by Dividend Reinvestment Plans (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 rather than DRIP 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 Danish reform in removing the possibility to conduct such tax arbitrage schemes. We confirm the 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 investor and firm behaviour. Post-reform, Denmark experienced a substantial increase in DWT revenues. Danish firms experienced a short-lived transitory negative stock market reaction to the announcement of DWT halt. Investment and dividend yield of Danish firms are not affected by the reform.

Although the results of our analysis provide evidence of the success of the Danish reform in countering existing tax arbitrage schemes, policymakers' attention to cum-cum and cum-ex transactions should remain high. The proper taxation of dividends and its enforcement is complex as capital is highly mobile and can easily escape taxation. We should 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 occurring.[30] Thus, further governmental action and international cooperation is needed to close the tax loopholes and safeguard against tax base erosion.

# References

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

Alstadsæter, Annette, Martin Jacob, and Roni Michaely (2017) 'Do dividend taxes affect corporate investment?' *Journal of Public Economics* 151, 74–83

[30]For more details, see https://www.bundestag.de/dokumente/textarchiv/2020/kw37-pa-finanzen-cum-ex-707204

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

Auerbach, Alan J (1979) 'Wealth maximization and the cost of capital.' *The Quarterly Journal of Economics* 93(3), 433–446

Auerbach, Alan J, and Kevin A Hassett (2006) 'Dividend taxes and firm valuation: New evidence.' *American Economic Review* 96(2), 119–123

Bach, Laurent, Antoine Bozio, Brice Fabre, Arthur Guillouzouic, Claire Leroy, and Clément Malgouyres (2019) 'Follow the money! combining household and firm-level evidence to unravel the tax elasticity of dividends.' mimeo Paris School of Economics

Bali, Rakesh, and Gailen L Hite (1998) 'Ex dividend day stock price behavior: discreteness or tax-induced clienteles?' *Journal of Financial Economics* 47(2), 127–159

Becker, Bo, Marcus Jacob, and Martin Jacob (2013) 'Payout taxes and the allocation of investment.' *Journal of Financial Economics* 107(1), 1–24

Blouin, Jennifer L, Jana S Raedy, and Douglas A Shackelford (2011) 'Dividends, share repurchases, and tax clienteles: Evidence from the 2003 reductions in shareholder taxes.' *The Accounting Review* 86(3), 887–914

Brav, Alon, John R Graham, Campbell R Harvey, and Roni Michaely (2005) 'Payout policy in the 21st century.' *Journal of financial economics* 77(3), 483–527

_ (2008) 'The effect of the may 2003 dividend tax cut on corporate dividend policy: Empirical and survey evidence.' *National Tax Journal* 61(3), 381–396

Brown, Jeffrey R, Nellie Liang, and Scott Weisbenner (2007) 'Executive financial incentives and payout policy: Firm responses to the 2003 dividend tax cut.' *The Journal of Finance* 62(4), 1935–1965

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

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

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

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

Desai, Mihir A, and Dhammika Dharmapala (2011) 'Dividend taxes and international portfolio choice.' *The Review of Economics and Statistics* 93(1), 266–284

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

Edgerton, Jesse (2010) 'Investment incentives and corporate tax asymmetries.' *Journal of Public Economics* 94(11-12), 936–952

_ (2013) 'Four facts about dividend payouts and the 2003 tax cut.' *International Tax and Public Finance* 20(5), 769–784

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

EY (2021) 'Brazilian house of deputies approves bill modifying the corporate income tax system as part of comprehensive tax reform.' `https://taxnews.ey.com/news/2021-1600-brazilian-house-of-deputies-approves-bill-modifying-the-corporate-income-tax-sy` Accessed on 30 June 2023

Farre-Mensa, Joan, Roni Michaely, and Martin Schmalz (2014) 'Payout policy.' *Annu. Rev. Financ. Econ.* 6(1), 75–134

Frank, Murray, and Ravi Jagannathan (1998) 'Why do stock prices drop by less than the value of the dividend? evidence from a country without taxes.' *Journal of Financial Economics* 47(2), 161–188

Isakov, Dušan, Christophe Pérignon, and Jean-Philippe Weisskopf (2021) 'What if dividends were tax-exempt? evidence from a natural experiment.' *The Review of Financial Studies* 34(12), 5756–5795

Jacob, Martin, and Maximilian Todtenhaupt (2023) 'Withholding taxes, compliance cost, and foreign portfolio investment.' *The Accounting Review* 98(2), 299–327

Johannesen, Niels (2014) 'Tax evasion and swiss bank deposits.' *Journal of Public economics* 111, 46–62

Johannesen, Niels, and Gabriel Zucman (2014) 'The end of bank secrecy? an evaluation of the g20 tax haven crackdown.' *American Economic Journal: Economic Policy* 6(1), 65–91

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

Keen, Michael, and Joel Slemrod (2017) 'Optimal tax administration.' *Journal of Public Economics* 152, 133–142

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*

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 (1983) 'Tax reform and ex-dividend day behavior.' *The Journal of Finance* 38(4), 1157–1179

Maffini, Giorgia, Jing Xing, and Michael P Devereux (2019) 'The impact of investment incentives: evidence from uk corporation tax returns.' *American Economic Journal: Economic Policy* 11(3), 361–89

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

Moon, Terry S (2022) 'Capital gains taxes and real corporate investment: Evidence from korea.' *American Economic Review* 112(8), 2669–2700

OECD (2020) 'Revenue statistics 2020'

Ohrn, Eric (2018) 'The effect of corporate taxation on investment and financial policy: Evidence from the dpad.' *American Economic Journal: Economic Policy* 10(2), 272–301

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

Poterba, James M, and Lawrence H Summers (1984) 'New evidence that taxes affect the valuation of dividends.' *The Journal of Finance* 39(5), 1397–1415

Segal, David (2020) 'It may be the biggest tax heist ever. and Europe wants justice.' `https://www.nytimes.com/2020/01/23/business/cum-ex.html`. Accessed on 12 September 2022

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*

_ (2021) '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

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

Warburton, Mike (2022) 'It's time to tax the dividends paid to foreign investors.' `https://www.telegraph.co.uk/tax/tax-hacks/time-tax-dividends-paid-foreign-investors/`. Accessed on 18 January 2022

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

# Figures and Tables


Figure 2: Timeline of the Danish Reform

*Notes*: The Figure provides the timeline for the introduction of the reform on the dividend withholding tax system in Denmark.

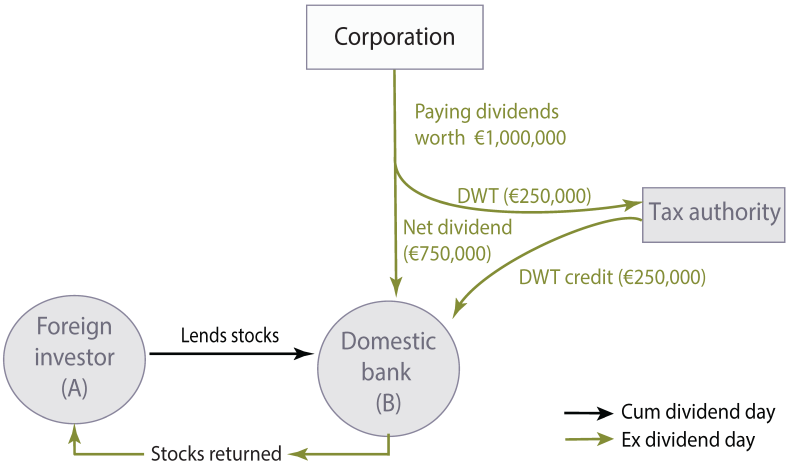



Figure 3: Example of a Cum-Cum Transaction

*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. Thus, typically, B is entitled to a full reimbursement of the dividend withholding tax (DWT). Investor A is not a resident of the same country of the Corporation. Thus, typically, investor A is not entitled to a (full) reimbursement of the DWT. The DWT is assumed to be 25%. At t, the Corporation pays a net dividend payment of EURO 750,000 to B and withholds 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.

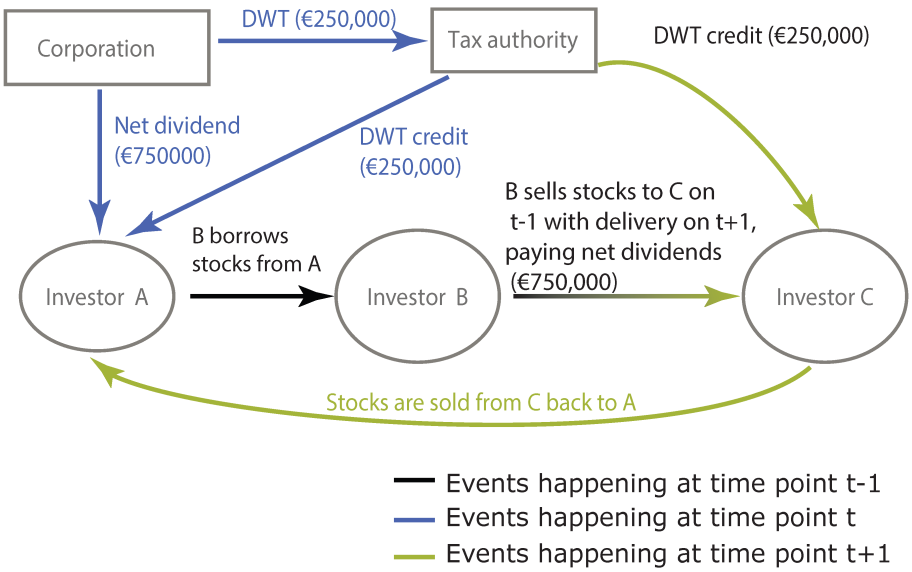
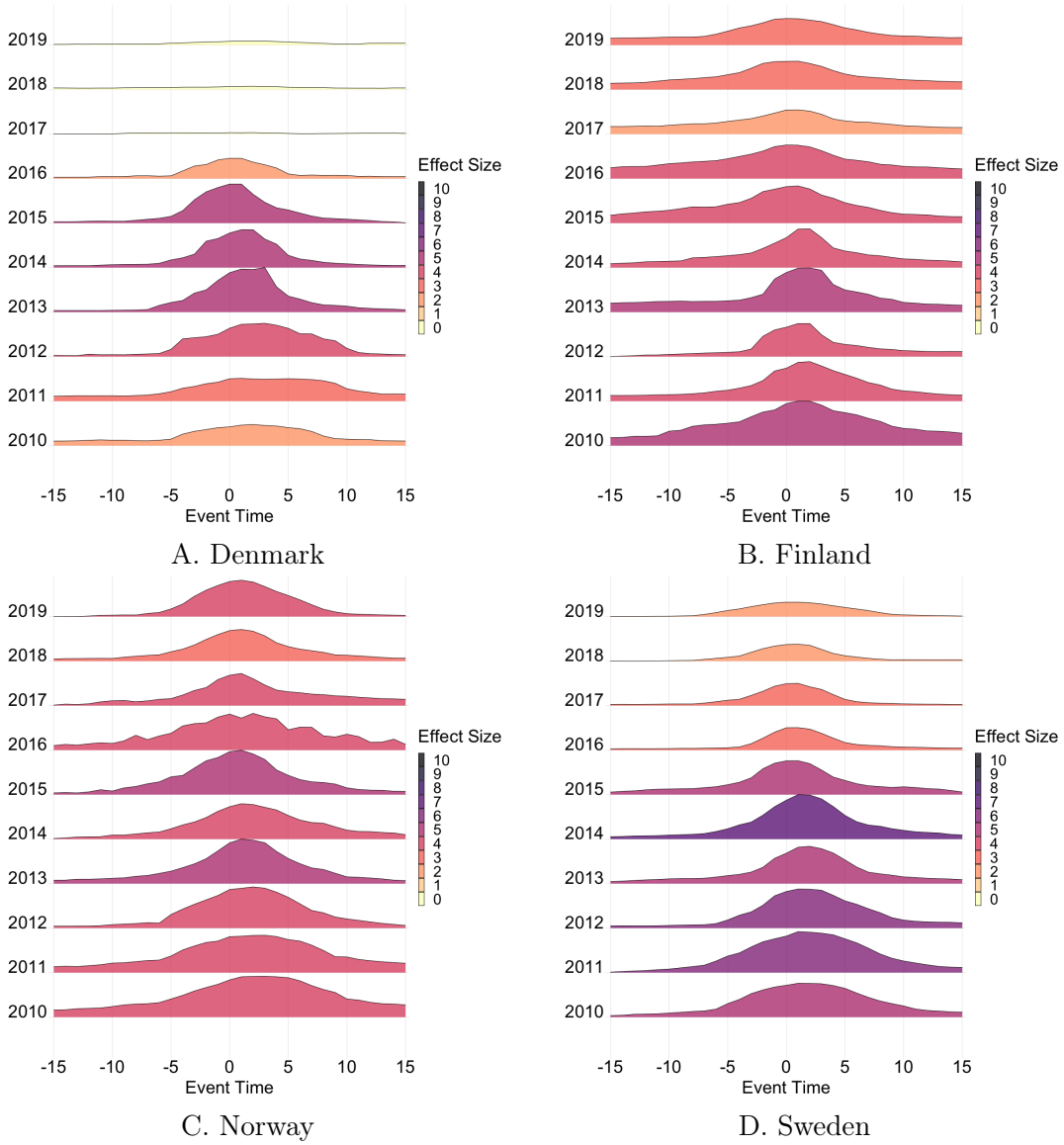



Figure 4: Example of a Cum-Ex Transaction

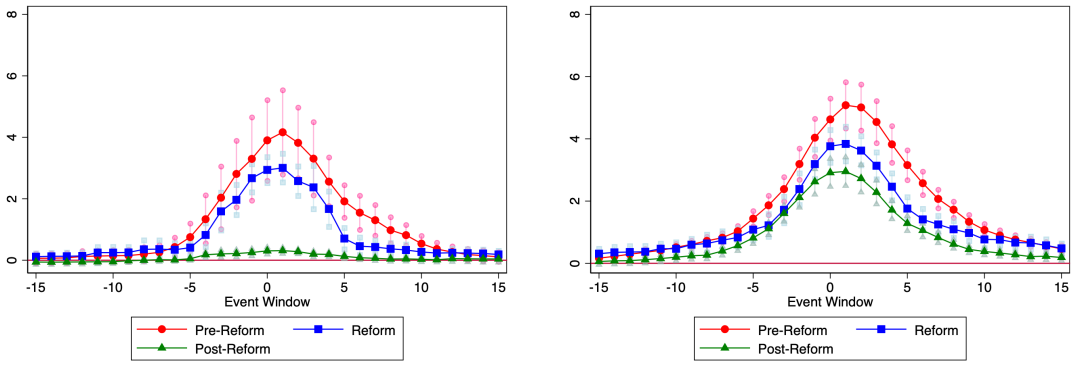
*Notes*: The Figure represents an example of a cum-ex transaction. The black arrows indicate the period t-1 before the dividend payment date, the blue arrows indicate the period t of the dividend payment date, and the green arrows indicate the period t+1 after the dividend payment date. Investor A owns the shares in the Corporation at time t-1. At t-1, 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 pays a net dividend payment of EUR 750,000 to B and withholds 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 5: Excess stocks on loan around the ex-dividend day




*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 as the coefficients $\beta_{\tau k}$ in equation (1), estimated using weighted-least squares and weighted by annual market capitalization. Standard errors are clustered at the issuing firm level.

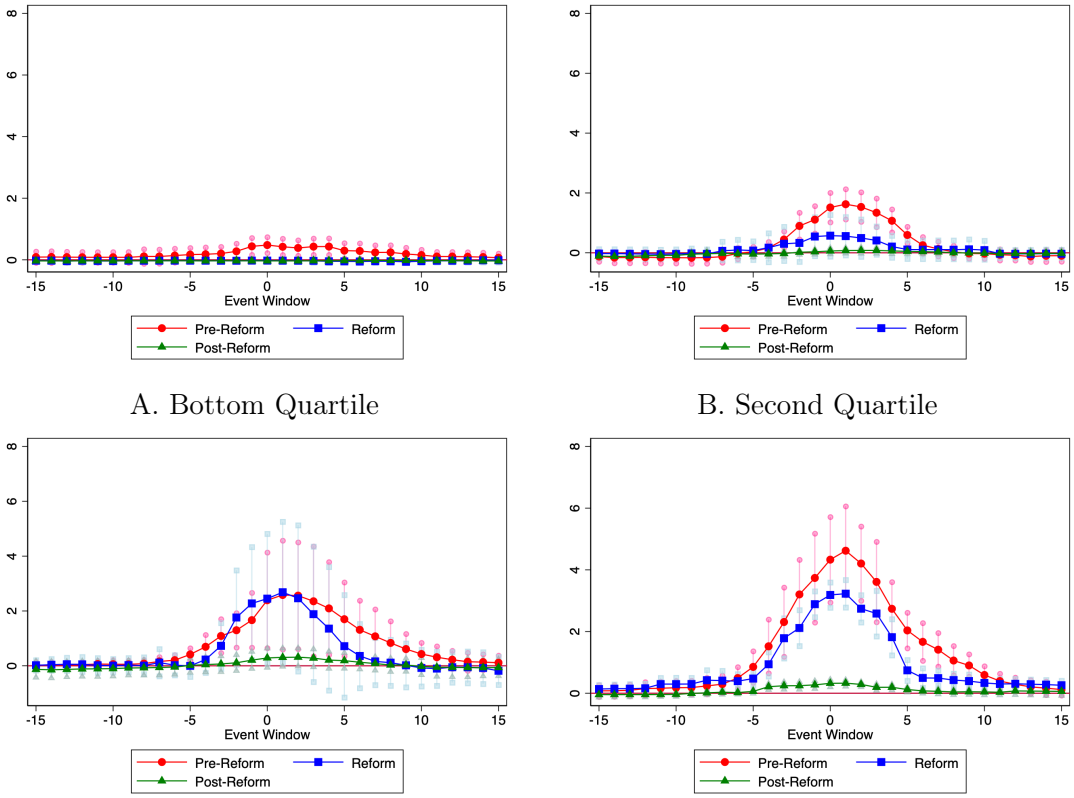
Figure 6: Excess stocks on loan aggregated by the treatment and control group, and treatment and control period




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 as the coefficients $\beta_{\tau k}$ in equation (1), estimated using weighted-least squares and weighted by annual market capitalization. Estimates are weighted by annual market capitalization. Standard errors are clustered at the issuing firm level. The resulting $\beta_{tk}$ are aggregated by i.) treatment group (Denmark)/control group (Finland, Norway and Sweden), and ii.) period: before the reform 2010 up to August 6th 2015, the reform-period from August 6th 2015-July 1st 2016 and the post-reform period from July 2nd 2016-2019, consistent with the timeline in Figure 2.

Figure 7: Heterogeneity in excess stocks on loan with respect to market capitalization for Denmark




A. Bottom Quartile

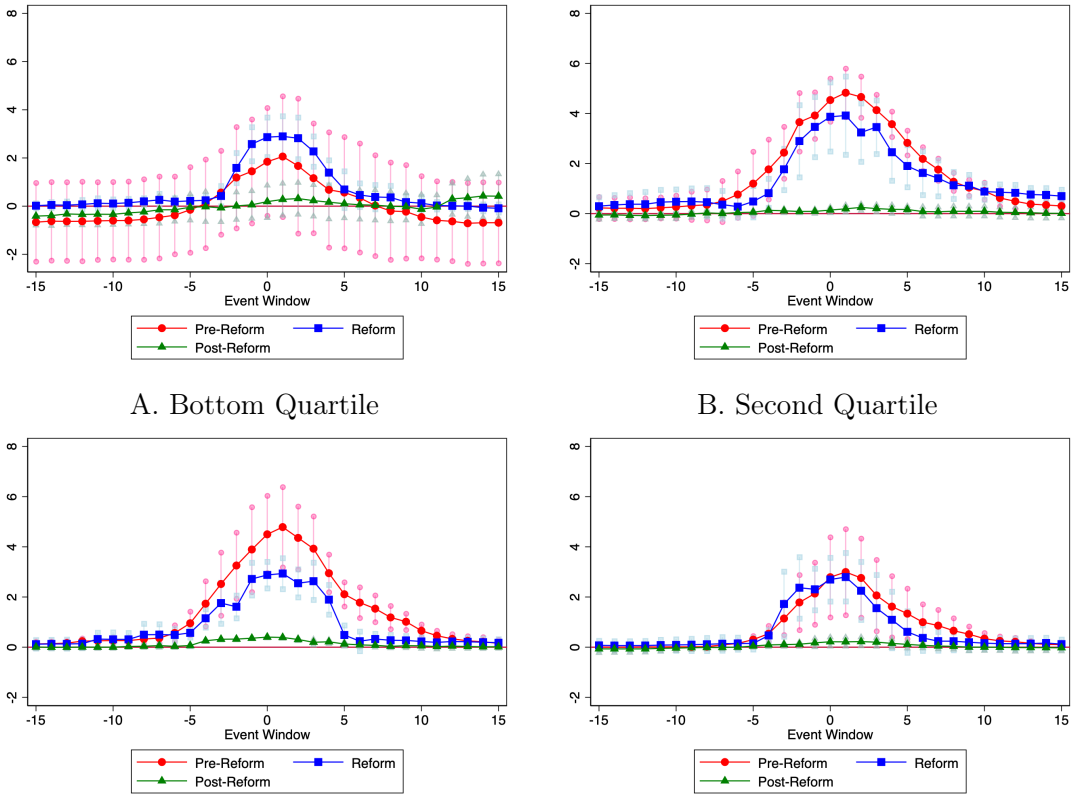
B. Second Quartile

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 long-term market capitalization. The excess stocks on loan are estimated as the coefficients $\beta_{\tau k}$ in equation (1) , estimated using weighted-least squares and weighted by annual market capitalization Standard errors are clustered at the issuing firm level. The resulting $\beta_{tk}$ are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 6th 2015, the reform-period from August 6th 2015-July 1st 2016 and the post-reform period from July 2nd 2016-2019, consistent with the timeline in Figure 2.

Figure 8: Heterogeneity in excess stocks on loan with respect to dividend yield for Denmark




A. Bottom Quartile

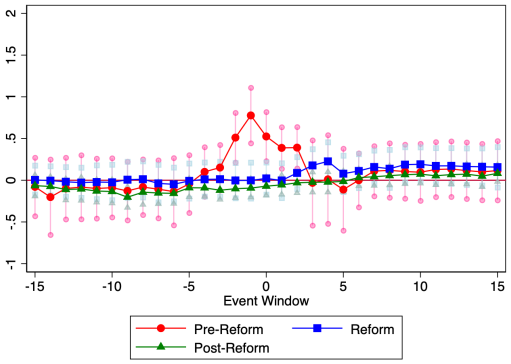
B. Second Quartile

C. Third Quartile

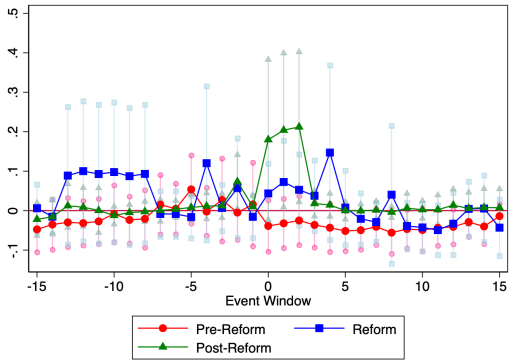
D. Top Quartile

*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 average dividend yield. The excess stocks on loan are estimated as the coefficients $\beta_{\tau k}$ in equation (1), estimated using weighted-least squares and weighted by annual market capitalization. Standard errors are clustered at the issuing firm level. The resulting $\beta_{tk}$ are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 6th 2015, the reform-period from August 6th 2015-July 1st 2016 and the post-reform period from July 2nd 2016-2019, consistent with the timeline in Figure 2.

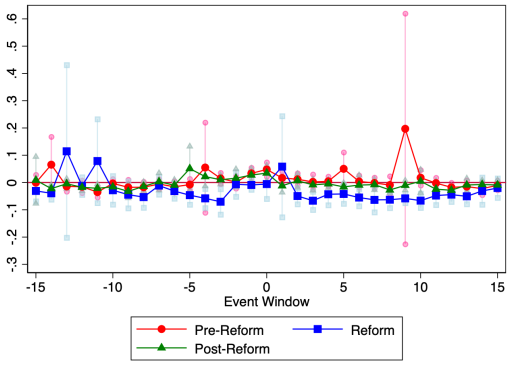
Figure 9: Event-study for additional outcome variables for Denmark



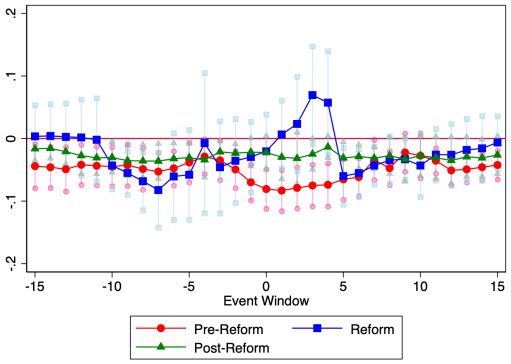

A. Quantity Available for Lending



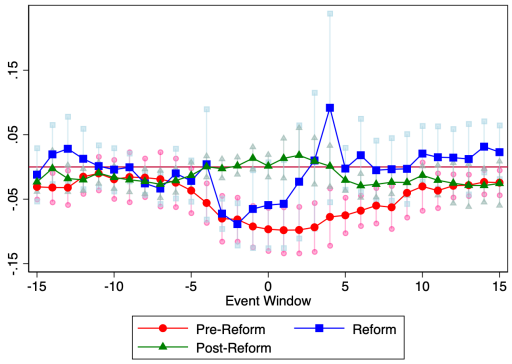

B. Cost of Borrowing




C. Turnover



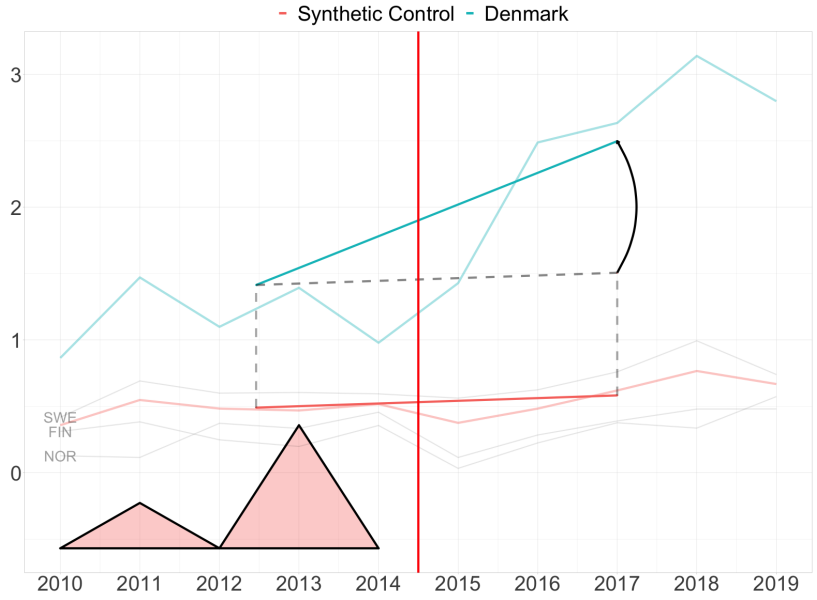

D. Borrower Concentration




E. Lender Concentration

*Notes*: The Figure plots event-study coefficients by outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each coefficient is estimated via event-study regression equation (1), estimated using weighted-least squares and weighted by annual market capitalization. Standard errors are clustered at the issuing firm level. which we estimate with weighted least squares. We use the annual market capitalization of a security as regression weights. The resulting $\beta_{tk}$ are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 6th 2015, the reform-period from August 6th 2015-July 1st 2016 and the post-reform period from July 2nd 2016-2019, consistent with the timeline in Figure 2.

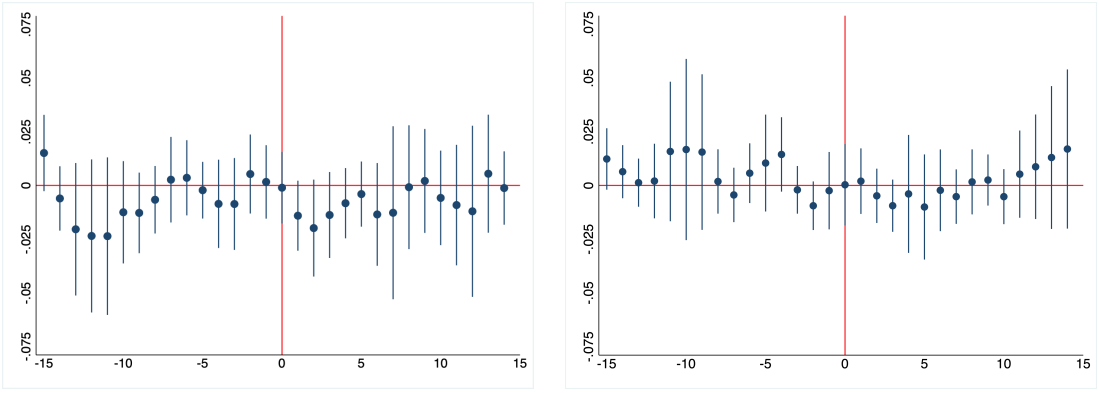
Figure 10: The Effect of the Reform on Net Dividend Withholding Tax Revenue




Net Dividend Withholding Tax Revenue

*Notes*: The Figure shows the causal effect of the Danish reform on Net Dividend Withholding Tax Revenue through synthetic DiD (Arkhangelsky et al., 2021). The blue line represents the time series for 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 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 triangles at the bottom of each plot represent the time-weights used in the pre-reform period to estimate the causal effect. The outcome variable is denominated in billions USD. Treatment begins in 2015. Table 4 contains the set of synthetic weights, and quantifies the causal effect.

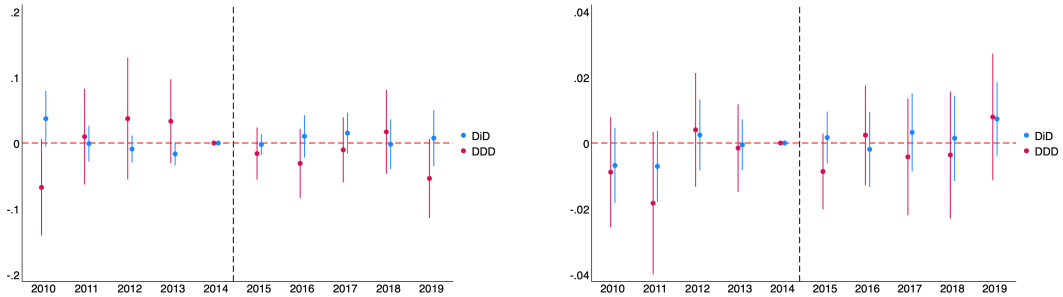
Figure 11: Effect of the Reform on Danish Stock Returns




A. 6 August 2015 B. 17 March 2016

*Notes*: The Figure plots the difference in 3-day cumulative abnormal returns between firms that are strongly treated by the reform, and firms that are not (see subsection 5.2.1) for the definition of treatment intensity, and the definition of abnormal returns.) The dates are explained in the timeline in Figure 2. The coefficients are estimated using regression equation (5), which contains non-parametric controls for firm size and sector. The model is estimated using weighted-least squares where the mean market capitalization during the sample period is utilized as weights. Error-bars represent a 95 % confidence interval. Standard errors are clustered at the issuing firm level.

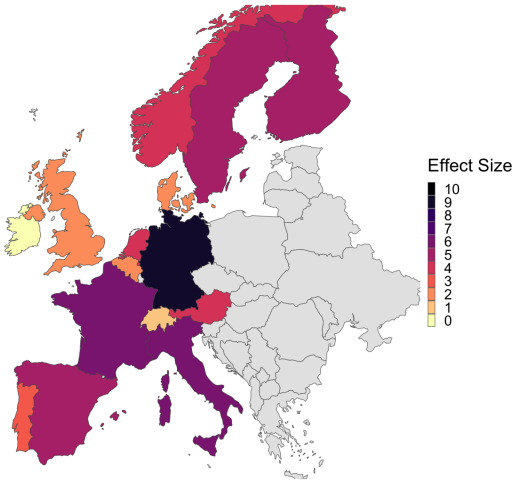
Figure 12: Effect of the Reform on Danish Investment Rate and Dividend Policy



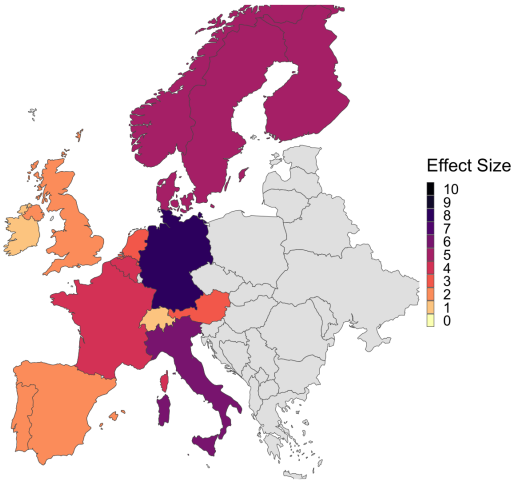

A. Investment Rate B. Dividend Yield

*Notes*: The Figure plots the DDD and DD coefficients by year on the outcome variable as listed in the caption. Each DDD coefficient is estimated via regression equation (6), which includes non-parametric controls for firm size and sector. The DD estimates are identified by comparing Danish firms to firms from other Nordic countries. The DDD also compares firms with high treatment intensity to firms with low treatment intensity (see subsection 5.2.1 for the definition of treatment intensity). The base year is 2014. The model is estimated using weighted-least squares where the mean market capitalization during the sample period is utilized as weights. Error-bars represent a 95 % confidence interval. Standard errors are clustered at the issuing firm level.

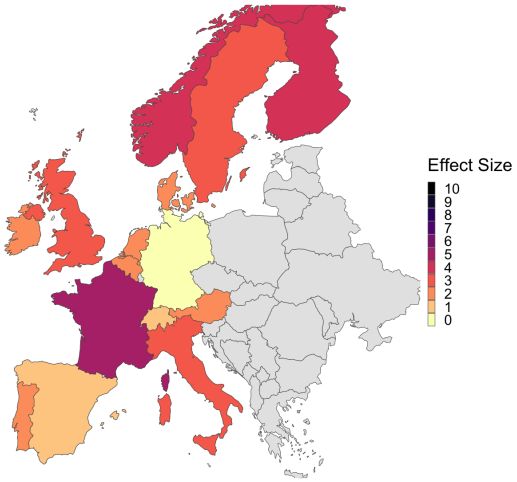
Figure 13: Excess stocks on loan in 15 European countries



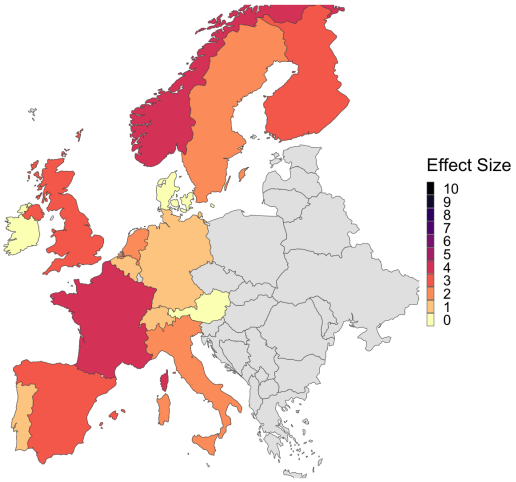

a. 2010




b.2013




a. 2016




b.2019

*Notes*: These maps plots the excess stocks on loan as a percentage of the public float. The map is color-coded according to the the maximum coefficient $\beta_{\tau k}$ from regression equation (1) subject to $\tau \in [-3, 3]$ (i.e. within 3 days of the ex-dividend date) by country and year. Estimates are weighted by annual market capitalization. Standard errors are clustered at the firm level. Non-significant estimates are color-coded as 0 (yellow). Data for countries coded in gray is not available.

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 presents 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 for Security-Lending Data

| | Denmark | | Finland | | Norway | | Sweden | | Outside |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After | Event Window |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Stocks on Loan | 4.092 | 1.172 | 5.558 | 3.398 | 4.375 | 3.601 | 6.133 | 3.710 | 1.280 |
| | (2.263) | (1.310) | (3.504) | (2.295) | (2.464) | (2.259) | (3.673) | (2.500) | (1.938) |
| Stocks Available for Lending | 14.91 | 16.70 | 13.88 | 14.22 | 9.453 | 10.35 | 17.23 | 15.64 | 14.48 |
| | (6.433) | (5.975) | (7.320) | (7.798) | (4.437) | (5.440) | (8.200) | (6.488) | (6.988) |
| Turnover | 0.231 | 0.200 | 0.390 | 0.227 | 0.255 | 0.168 | 0.385 | 0.301 | 0.253 |
| | (0.192) | (0.145) | (0.386) | (0.178) | (0.291) | (0.150) | (0.352) | (0.257) | (0.408) |
| Cost of Borrowing | 1.179 | 1.234 | 1.499 | 1.168 | 1.317 | 1.143 | 1.403 | 1.231 | 1.235 |
| | (0.752) | (0.944) | (1.513) | (0.844) | (1.144) | (0.684) | (1.270) | (0.933) | (0.814) |
| Lender Concentration | 0.169 | 0.257 | 0.217 | 0.222 | 0.169 | 0.182 | 0.202 | 0.236 | 0.253 |
| | (0.156) | (0.182) | (0.192) | (0.189) | (0.163) | (0.154) | (0.174) | (0.184) | (0.188) |
| Borrower Concentration | 0.228 | 0.242 | 0.176 | 0.216 | 0.160 | 0.241 | 0.198 | 0.234 | 0.257 |
| | (0.168) | (0.142) | (0.170) | (0.187) | (0.162) | (0.133) | (0.167) | (0.161) | (0.169) |
| Number of Events | 203 | 159 | 346 | 206 | 293 | 253 | 839 | 790 | 0 |
| $N$ | 1335 | 1112 | 2248 | 1395 | 1909 | 1667 | 5396 | 5146 | 753183 |
| $N$ | 5844 | 4942 | 9772 | 6150 | 8419 | 7376 | 23341 | 22447 | 753183 |

*Notes*: The Table presents summary statistics for the variables used in the analysis. 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 columns Before refer to the period from 2010 to August 26th 2015. The columns After refers to the period from July 2nd 2016-2019, consistent with the timeline in Figure 2. The Reform period is shown in Table A.1. 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. All statistics are weighted by market capitalization. Standard deviations are in parenthesis.

Table 3: Summary Statistics Annual Data

| | Denmark | | Finland | | Norway | | Sweden | |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Net DWT Revenue | 1162.6 | 2500.7 | 299.1 | 308.7 | 277.9 | 350.1 | 582.1 | 737.2 |
| | (262.9) | (646.5) | (76.37) | (199.3) | (156.9) | (154.3) | (99.85) | (166.3) |
| *Statistics for Liquidity-Constrained Firms* | | | | | | | | |
| Investment Rate | 0.125 | 0.107 | 0.123 | 0.0979 | 0.177 | 0.159 | 0.149 | 0.148 |
| | (0.0542) | (0.0422) | (0.110) | (0.105) | (0.0742) | (0.0567) | (0.0770) | (0.0672) |
| Dividend Yield | 0.0166 | 0.0156 | 0.0403 | 0.0321 | 0.0417 | 0.0398 | 0.0379 | 0.0404 |
| | (0.0163) | (0.0110) | (0.0245) | (0.0129) | (0.0200) | (0.0164) | (0.0215) | (0.0190) |
| *Statistics for Unconstrained Firms* | | | | | | | | |
| Investment Rate | 0.137 | 0.175 | 0.126 | 0.128 | 0.135 | 0.144 | 0.138 | 0.130 |
| | (0.0485) | (0.0571) | (0.0646) | (0.0808) | (0.0927) | (0.104) | (0.0822) | (0.0801) |
| Dividend Yield | 0.0186 | 0.0207 | 0.0413 | 0.0377 | 0.0303 | 0.0248 | 0.0303 | 0.0263 |
| | (0.0143) | (0.0107) | (0.0182) | (0.0187) | (0.0213) | (0.0164) | (0.0129) | (0.0160) |

*Notes*: The Table presents summary statistics for the variables used in the analysis. The columns Before refer to the period from 2010 to 2014. The columns After refers to the period from 2015-2019, consistent with the timeline in Figure 2. Net DWT Revenue is the difference between gross DWT revenue and reimbursements measured in USD. % Reimbursements represent tax reimbursements as a percentage of Gross DWT Revenue. Firms are considered liquidity constrained if during at least one of the pre-reform years earnings are insufficient to cover capital expenditure.
Tax revenue is observed at the country-year level, and hence has 40 observations. The statistics for Dividend Yield and Investment are weighted by market capitalization. The number of observations for constrained firms and unconstrained firms are, respectivelly, 1242 and 1723. Standard deviations are in parenthesis.

Table 4: Synthetic Difference-in-Difference

| | Net DWT Revenue |
|---|---|
| | (1) |
| SDiD Denmark | 0.991 |
| | (0.064) |
| Synthetic Weights: | |
| Sweden | 0.63 |
| Finland | 0.26 |
| Norway | 0.11 |

*Notes*: This Table presents the causal effect of the Danish reform on the outcome variable listed in the column title. The estimates are obtained via synthetic DiD (cf. Arkhangelsky et al., 2021). The standard error is obtained through the placebo method. The variables are denominated in billions of USD.

# For Online Publication: Appendix

## A1 Examples of Cum-Cum and Cum-Ex Transactions

*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 3 illustrates how the above-described DWT arbitrage strategy can lead to the avoidance of the DWT.[31] 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 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.[32]

*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.[33]

As visible in Figure 4, 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

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

[32] 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.

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

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 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.[34]

## 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.[35] 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 in Figure 6 which includes DRIP events .

[34]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.

[35]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.

## A3 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.[36]

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 and Australia.

Figure A.7 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.

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

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 13).

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 9 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.

## A4 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.[37]

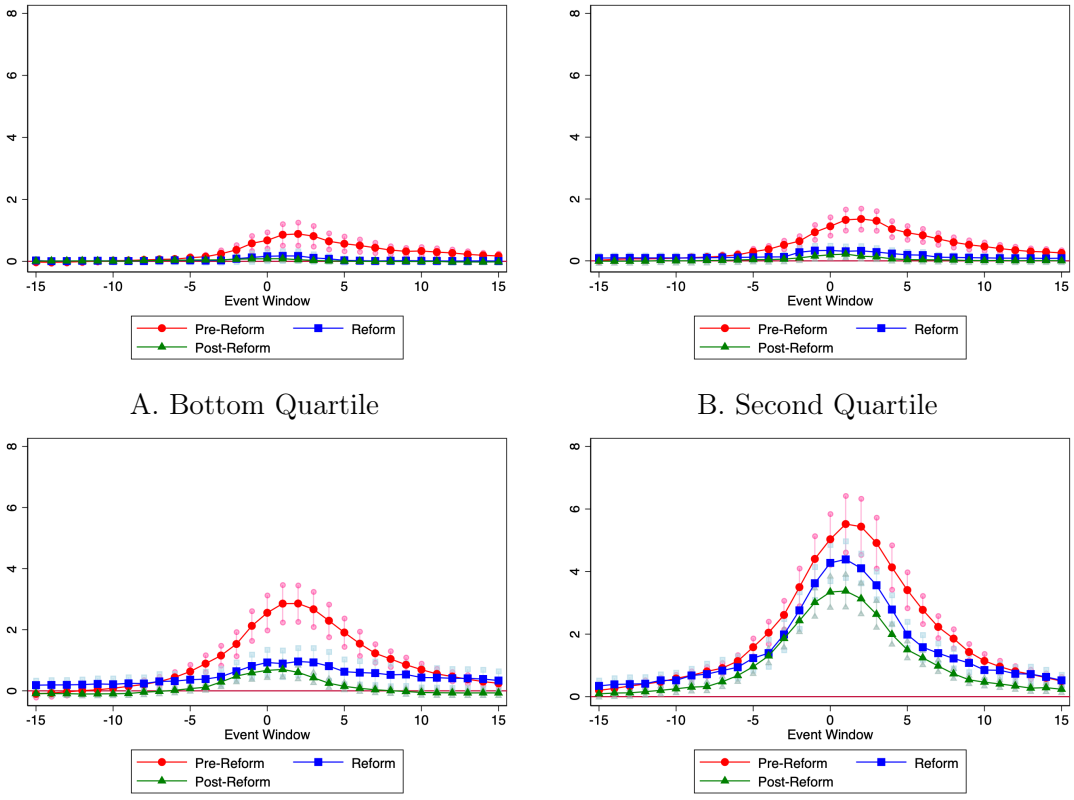
Figure A.8 plots the result for both specifications. We replicate the finding of the ESMA by showing that there is indeed a significant increase in stock lending around the ex-dividend

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

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.

## A5 Appendix Figures and Tables

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




A. Bottom Quartile

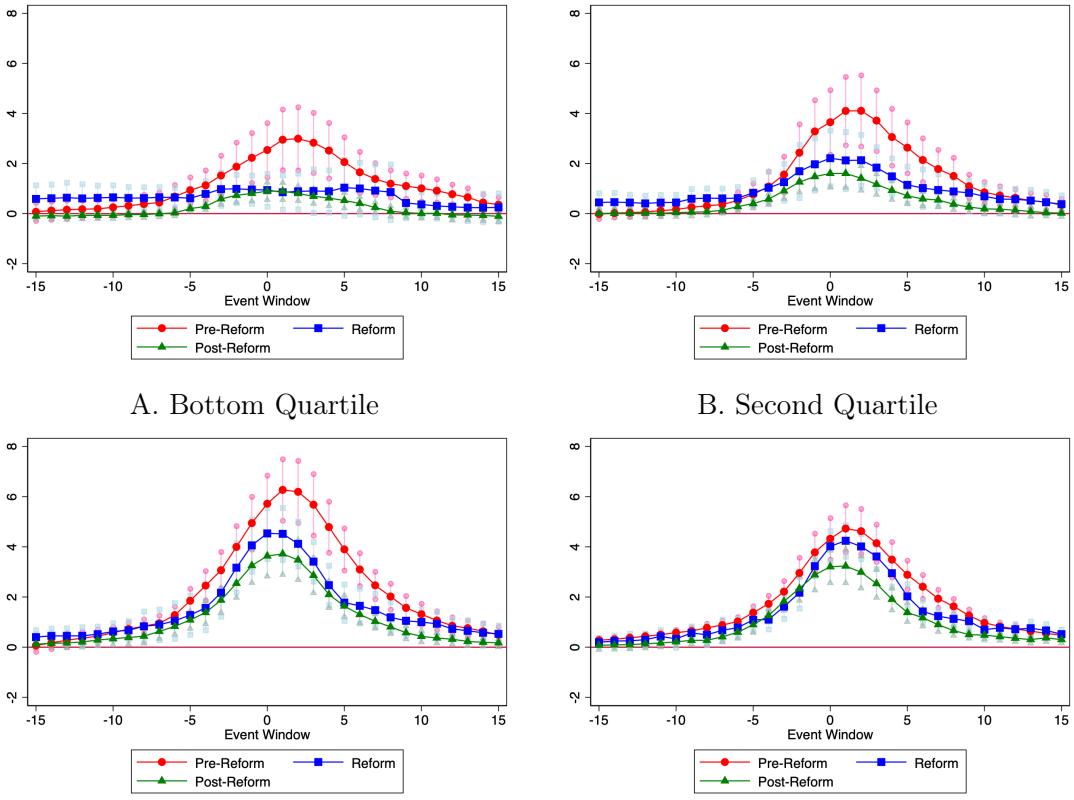
B. Second Quartile

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). Estimates are weighted by annual market capitalization. The resulting $\beta_{tk}$ are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010- August 26th 2015), the reform-period (August 26th 2015 - July 1st 2016) and the post-reform period (July 2nd 2016-2019), consistent with Figure 2. 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

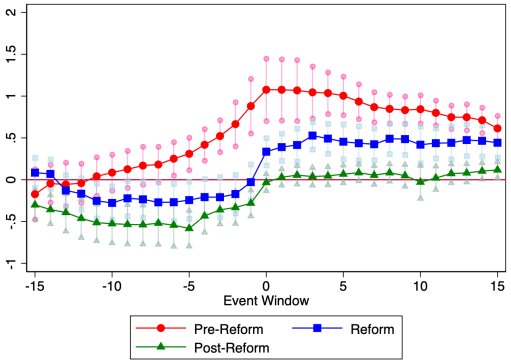
B. Second Quartile

C. Third Quartile

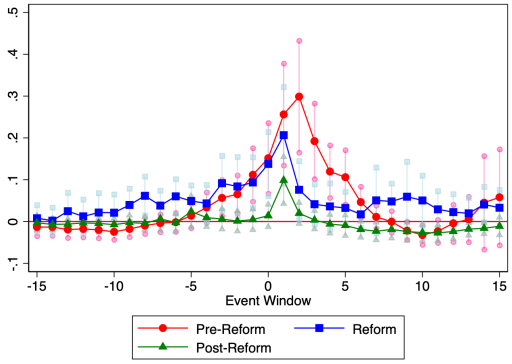
D. Top Quartile

*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). Estimates are weighted by annual market capitalization. The resulting $\beta_{tk}$ are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010- August 26th 2015), the reform-period (August 26th 2015 - July 1st 2016) and the post-reform period (July 2nd 2016-2019), consistent with Figure 2. Standard errors are clustered at the issuing company level.

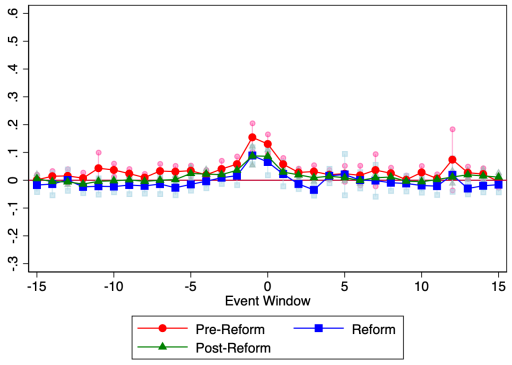
Figure A.3: Event study for additional outcome variables for the control group



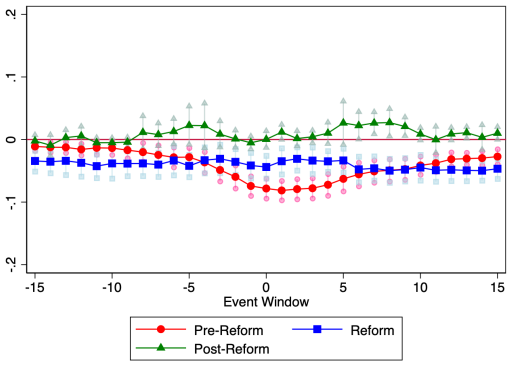

A. Quantity Available for Lending



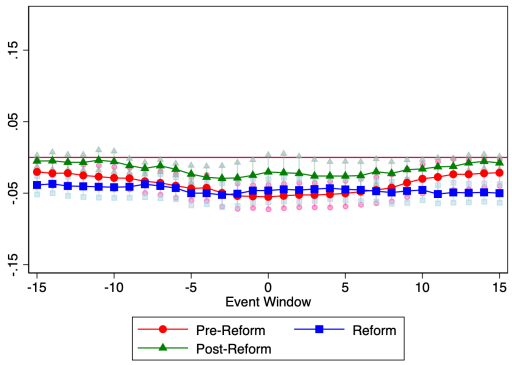

B. Cost of Borrowing




C. Turnover



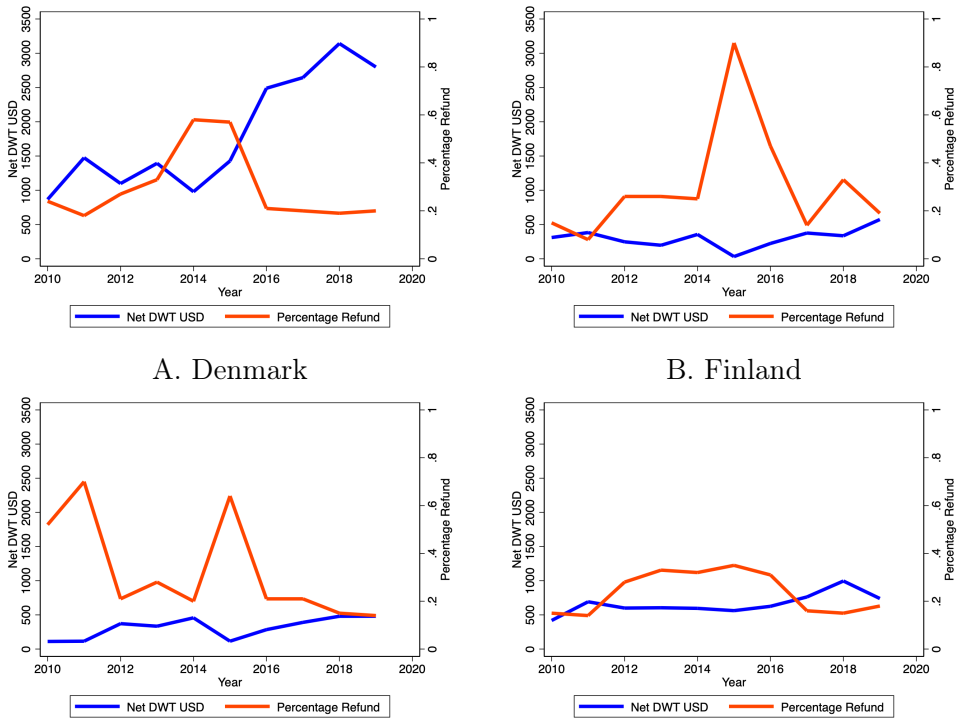

D. Borrower Concentration




E. Lender Concentration

*Notes*: The Figure plots event-study coefficients by outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each coefficient is estimated via event-study regression equation (1), estimated using weighted-least squares and weighted by annual market capitalization. The resulting $\beta_{tk}$ are aggregated by control group (Finland, Norway and Sweden), and ii.) by period: before the reform (2010-August 26th 2015), the reform-period (August 26th 2015 - July 1st 2016) and the post-reform period (July 2nd 2016-2019), consistent with Figure 2. Standard errors are clustered at the issuing company level.

Figure A.4: Net DWT revenue and reimbursements

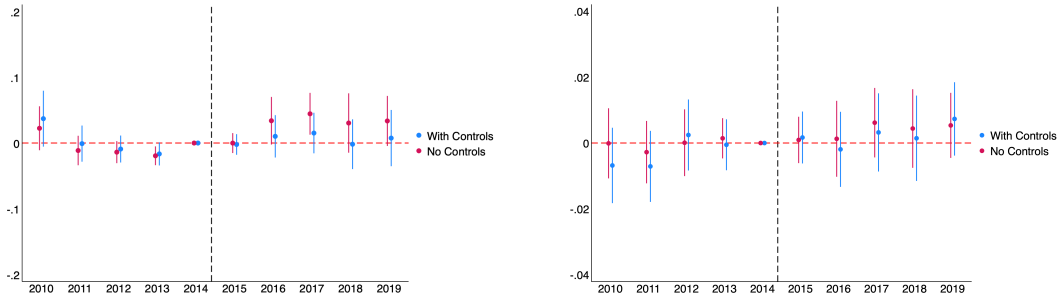



A. Denmark B. Finland

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 and year.

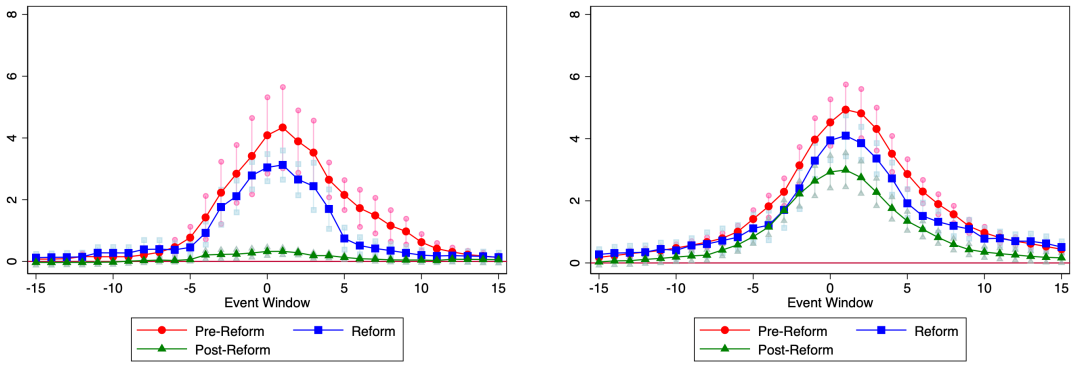
Figure A.5: Effect of the Reform on Danish Investment Rate and Dividend Policy without control variables




A. Investment Rate B. Dividend Yield

*Notes*: The Figure plots the DD for the outcome variable in the caption identified by comparing Danish firms to firms from other Nordic countries with controls for firm size and sector, and without control variables. The base year is 2014. The model is estimated using weighted-least squares where the mean market capitalization during the sample period is utilized as weights. Error-bars represent a 95 % confidence interval. Standard errors are clustered at the issuing firm level.

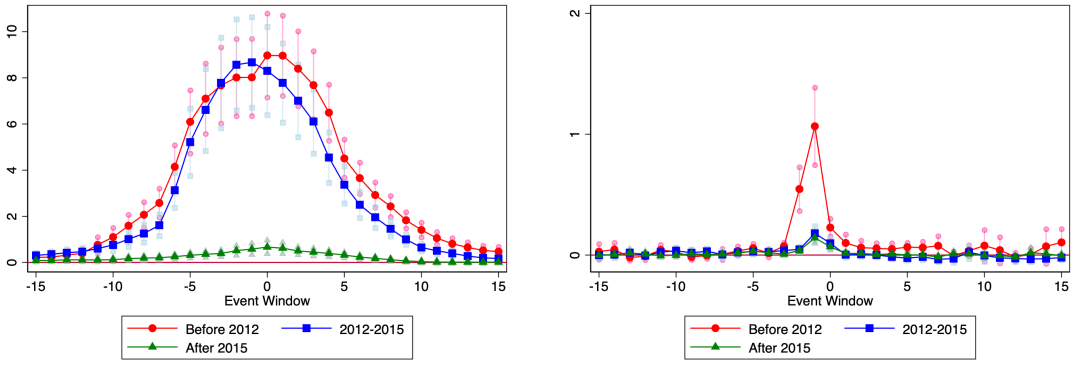
Figure A.6: Event Study Excluding Dividend Distributions with DRIP




A. Denmark B. Control Group

*Notes*: The Figure replicates Figures 5 on a sample that excludes DRIP-dividend distributions. 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 average dividend yield. The excess stocks on loan are estimated as the coefficients $\beta_{\tau k}$ in equation (1). Estimates are weighted by annual market capitalisation. Standard errors are clustered at the issuing company level. The resulting $\beta_{tk}$ are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 6th 2015, the reform-period from August 6th 2015-July 1st 2016 and the post-reform period from July 2nd 2016-2019, consistent with the timeline in Figure 2.

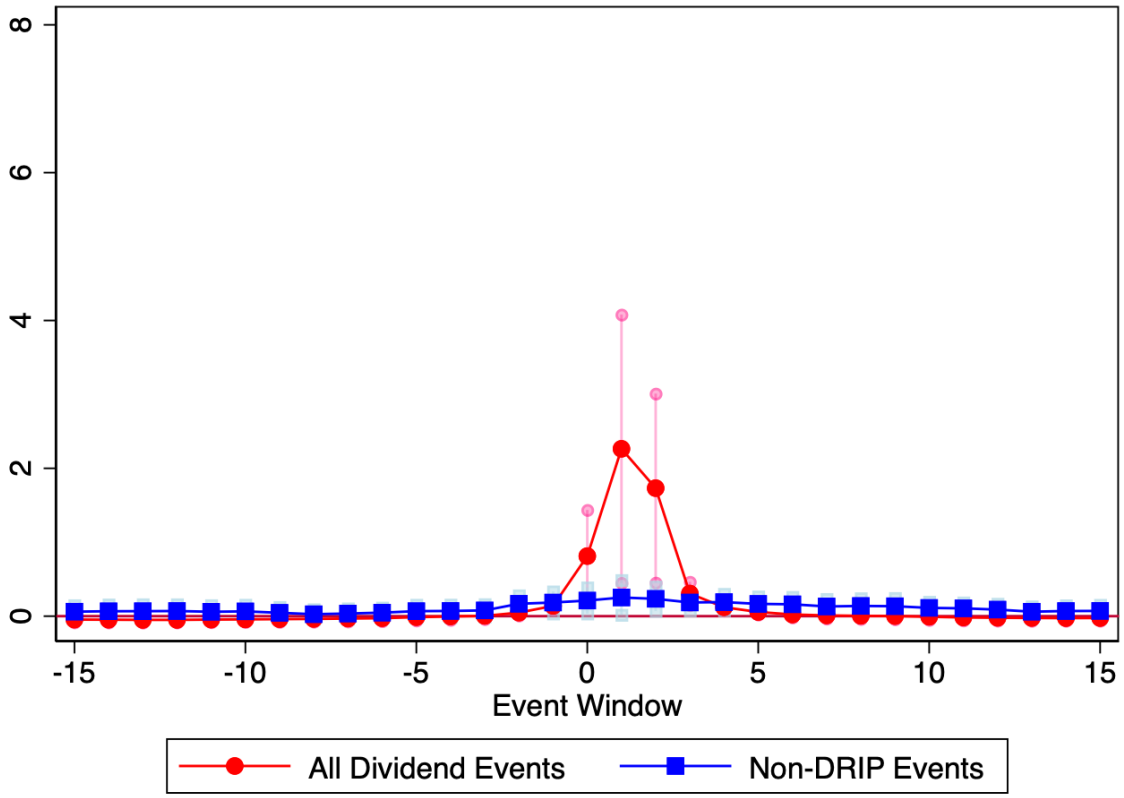
Figure A.7: Germany




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). Estimates are weighted by annual market capitalization. The resulting $\beta_{tk}$ 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.8: 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). Estimates are weighted by annual market capitalization. The resulting $\beta_{tk}$ 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.

Table A.1: Full Summary Statistics

| | Denmark | | | Finland | | | Norway | | | Sweden | | | Outside |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before | Reform | After | Before | Reform | After | Before | Reform | After | Before | Reform | After | Event Window |
| *Panel A. Daily Data* | | | | | | | | | | | | | |
| Stocks on Loan | 4.092 | 3.334 | 1.172 | 5.558 | 5.391 | 3.398 | 4.375 | 4.866 | 3.601 | 6.133 | 4.136 | 3.710 | 1.280 |
| | (2.263) | (1.842) | (1.310) | (3.504) | (2.398) | (2.295) | (2.464) | (2.528) | (2.259) | (3.673) | (2.802) | (2.500) | (1.938) |
| Stocks Available for Lending | 14.91 | 16.31 | 16.70 | 13.88 | 17.55 | 14.22 | 9.453 | 11.31 | 10.35 | 17.23 | 14.62 | 15.64 | 14.48 |
| | (6.433) | (5.950) | (5.975) | (7.320) | (6.409) | (7.798) | (4.437) | (4.355) | (5.440) | (8.200) | (6.803) | (6.488) | (6.988) |
| Turnover | 0.231 | 0.202 | 0.200 | 0.390 | 0.310 | 0.227 | 0.255 | 0.197 | 0.168 | 0.385 | 0.288 | 0.301 | 0.253 |
| | (0.192) | (0.264) | (0.145) | (0.386) | (0.233) | (0.178) | (0.291) | (0.188) | (0.150) | (0.352) | (0.333) | (0.257) | (0.408) |
| Cost of Borrowing | 1.179 | 1.190 | 1.234 | 1.499 | 1.273 | 1.168 | 1.317 | 1.256 | 1.143 | 1.403 | 1.436 | 1.231 | 1.235 |
| | (0.752) | (0.852) | (0.944) | (1.513) | (1.034) | (0.844) | (1.144) | (0.875) | (0.684) | (1.270) | (1.215) | (0.933) | (0.814) |
| Lender Concentration | 0.169 | 0.195 | 0.257 | 0.217 | 0.171 | 0.222 | 0.169 | 0.158 | 0.182 | 0.202 | 0.198 | 0.236 | 0.253 |
| | (0.156) | (0.151) | (0.182) | (0.192) | (0.200) | (0.189) | (0.163) | (0.126) | (0.154) | (0.174) | (0.180) | (0.184) | (0.188) |
| Borrower Concentration | 0.228 | 0.333 | 0.242 | 0.176 | 0.196 | 0.216 | 0.160 | 0.175 | 0.241 | 0.198 | 0.247 | 0.234 | 0.257 |
| | (0.168) | (0.184) | (0.142) | (0.170) | (0.172) | (0.187) | (0.162) | (0.141) | (0.133) | (0.167) | (0.176) | (0.161) | (0.169) |
| $N$ | 1335 | 282 | 1112 | 2248 | 360 | 1395 | 1909 | 307 | 1667 | 5396 | 1167 | 5146 | 753183 |
| $N$ | 5844 | 1243 | 4942 | 9772 | 1573 | 6150 | 8419 | 1431 | 7376 | 23341 | 5211 | 22447 | 753183 |
| Number of Events | 203 | 41 | 159 | 346 | 56 | 206 | 293 | 45 | 253 | 839 | 177 | 790 | 0 |

*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 columns Before refer to the period from 2010 to August 26th 2015. The columns Reform capture the interval from August 26th 2015-July 1st 2016. The columns After refers to the period from July 2nd 2016-2019, consistent with the timeline in Figure 2. 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. All statistics are weighted by market capitalization. Standard deviations are in parenthesis.

## References


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

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

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

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

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

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