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

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

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

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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. Before the reform, all countries have strong spikes in stocks on loan centered around the ex-dividend day, consistent with the most popular DWT arbitrage transactions. Post-reform, the spikes in Denmark disappear. We find that stricter enforcement resulted in approx. 1.3 bln USD in annual DWT revenue (130 % of pre-reform revenue) with no effect on cost of capital and dividend policy. We find similar results in reforms across Europe.

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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 fix the loopholes by introducing new regulations. However, little is known about whether these enforcement efforts i.) reduce the number of dividend-arbitrage transactions, ii.) result in additional tax revenue, and iii.) affect the cost of capital, stock market returns and dividend policy.[1][2] Even if enforcement is successful in reducing dividend arbitrage, this does not necessarily translate to higher tax

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[1]There are a handful of articles that study the effect of dividend tax enforcement on financial markets (e.g. Lakonishok and Vermaelen, 1983; Poterba and Summers, 1984; Buettner et al., 2019). To our knowledge, only Lakonishok and Vermaelen (1983); Buettner et al. (2019) study the effect on transaction volume. There exists no studies that look into broader welfare consequences such as the effect on tax revenue.

[2]There exists a much larger literature that studies the effect of reforms in dividend tax rates: (e.g Chetty and Saez, 2005; Yagan, 2015; Boissel and Matray, 2022; Moon, 2022). However, this literature typically does not consider dividend arbitrage.

revenue, since mechanical revenue gains may be crowded out by behavioral responses (see e.g. Keen and Slemrod (2017)).

We address this issue by studying an enforcement reform in the Danish dividend-withholding tax (DWT) in 2016. In 2015 Danish tax authorities discovered large-scale dividend arbitrage transactions that exploit the reimbursement system for the DWT. In June 2016 the Danish parliament passed new legislation which requires additional documentation, and intends to effectively diminish the profitability of these transactions. We study the effect of the Danish reform on DWT arbitrage, and additionally, study the broader welfare consequences on tax revenue, cost of capital and dividend policy.

Although our main focus is on the Danish reform, it is important to note that the issue of DWT arbitrage is not limited to Denmark. Reporting in the "Cum-ex files" by the journalistic consortium CORRECTIV (2021) indicates that this type of arbitrage is common 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".[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). Partially for this reason the European Commission has recently signaled its commitment for harmonizing DWT[4] and reimbursement systems across its member states. Meanwhile, the UK which abolished the DWT in 2008, has started a discussion on reintroducing it (Warburton, Mike (2022). 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 the foreign investor enters into an agreement with a domestic bank to lend its shares shortly 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 (see e.g.

[3]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.

[4]For more details, see `https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13031-Withholding-taxes-new-EU-system-to-avoid-double-taxation/public-consultation_en`

Figure 1).

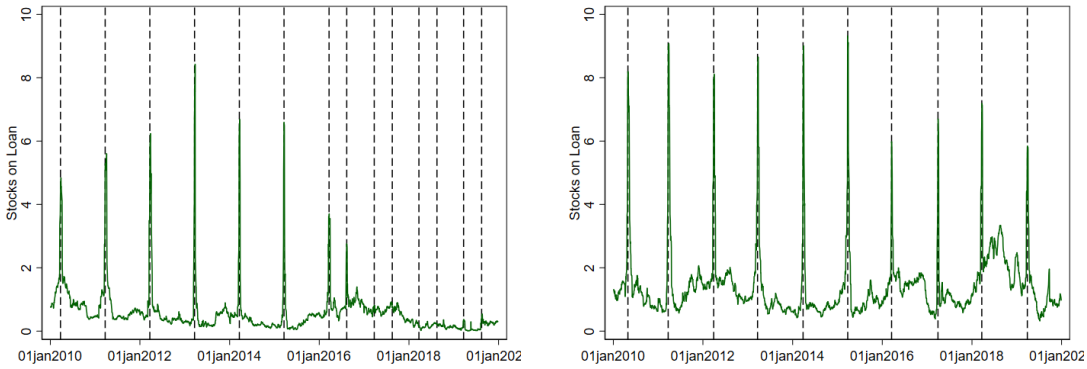
Our analysis consists of three parts. First, we consider the effect of the the Danish reform on cum-cum and cum-ex transactions, as observed by the spikes in the security-lending market. Second, we explore the broader welfare consequences by studying tax revenue, foreign portfolio investment (FPI), stock returns 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. In 2016, Denmark introduced a reform to its DWT reimbursement system. The reform thus targets cum-cum and cum-ex transactions, but leaves non-tax related arbitrage transactions unaffected, allowing us to separately identify tax arbitrage from non-tax arbitrage. Second, through close cooperation with the tax authorities in the four respective countries we have obtained detailed DWT revenue data that includes both annual tax receipts and reimbursements. To our knowledge DWT revenue data has never been analyzed before, and is not available for any of the other Western-European countries in our study.

Our 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 2016 reform.

Figure 1 provides a raw-data example of our identification strategy. The Figure plots the stocks on loan, sometimes referred to as short interest, over time for the Danish pharmaceutical company Novo Nordisk (panel A), and the Swedish bank Svenska Handelsbanken (panel B). Prior to the reform in mid-2016 both companies see abrupt spikes in 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 companies was on loan in the dividend period. This spike disappears in Danish companies, but continues in Finnish, Norwegian and Swedish companies. To understand the magnitude, in the US, Dixon et al. (2021) find a spike in stock lending of 0.6 percent of the public float. The effect we find is about 6.5 time larger. This indicates that DWT arbitrage in Europe is much more prevalent than in the US, consistent with the findings of CORRECTIV (2021), and with the institutional setting which provides much stronger incentives for DWT arbitrage



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.

in Europe than in the US.[5]

In the second part of our analysis, we consider the welfare consequences of the reform. We first consider the effect on tax revenue. Using Syntethic DiD (Arkhangelsky et al., 2021), we compare net DWT revenue in Denmark to a weighted average of Finland, Norway and Sweden. We find that annual DWT revenue in Denmark increases by approximately 1.3 Billion USD. This number represents 130 percent of the net DWT revenue Denmark obtained prior to the reform in 2014. Descriptive statistics indicate that the increase in DWT revenue was mostly the result of a reduction in reimbursements, consistent with the purpose of the reform.

Second, we consider whether the Danish reform has negatively affected the cost of capital for Danish corporations. We approach this cost of capital from two angles. First, we estimate the effect of the reform on FPI in Denmark, with the idea that less foreign portfolio investment implies a higher cost of capital. Using bilateral data from the IMF on foreign equity investment into the Nordics in a synthetic DID framework we find no significant reduction in Danish FPI relative to synthetic Denmark. Second, we consider whether announcement of the reform has impacted stock market returns in Denmark, relative to the other Nordics using a financial event-study. Here the idea is that lower stock prices result in a higher cost of capital. We estimate abnormal returns on Danish stocks by predicting the returns to Danish stocks on the basis of an index of Nordic stocks that excludes Denmark. We then compare the abnormal returns of Danish stocks that regularly pay dividends, and are hence affected by the reform, to those that do not. We find no evidence that any of the major announcement dates associated with the reform resulted in a significant change in stock market returns.

Finally, we consider whether the reform has affected dividend policy for Danish companies. Using a company-level event-study and controlling for industry-time effects we find no evidence

[5]We discuss in more detail the difference in the institutional setting between the US and Europe in Section 2.

that dividend yield (intensive margin) or dividend distributions (extensive margin) are affected by the reform. This indicates that stricter DWT enforcement in Denmark leads to higher tax revenue without affecting investors or company behavior. Hence, according to our analysis, the reform constitutes a large increase in tax revenue, without any corresponding negative impact on welfare.

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 payment 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 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. The introduction of reforms in DWT enforcement, like the ones introduced in Denmark and Germany, appears to eliminate arbitrage entirely. In Denmark, we see that this results in a strong increase in tax revenue, without affecting dividend policy or the cost of capital of Danish firms.

Related Literature There is a vast literature that focuses on dividend taxation. One strand studies the economic effect of changes in dividend tax rate (e.g. Chetty and Saez, 2005; Brown et al., 2007; Blouin et al., 2011; Edgerton, 2013; Yagan, 2015; Boissel and Matray, 2022; Moon, 2022). Another strand studies the effect of dividend tax enforcement on financial markets (e.g. Lakonishok and Vermaelen, 1983; Poterba and Summers, 1984) and a few studies focus on the same type of DWT arbitrage as the one in our study. Using lending data, Christoffersen et al. (2005) and Dixon et al. (2021) document the extent to which DWT arbitrage is present in UK, Canada and US respectively. Buettner et al. (2019) study the effect of a German 2012 reform aimed at preventing cum-ex using turnover data from the German stock exchange. Our paper extends previous studies by providing a comprehensive analysis of the economic effect of stricter DWT enforcement. In addition, we contribute by documenting empirically the extent to which DWT arbitrage strategies have been conducted in 15 major EU countries.

Our paper also contributes to the literature that studies arbitrage mechanisms around dividend payments (e.g. Poterba and Summers, 1984; Karpoff and Walkling, 1990; McDonald, 2001; Akhmedov and Jakob, 2010; Hartzmark and Solomon, 2013; Henry and Koski, 2017). We contribute by quantifying the extent to which arbitrage around the ex-dividend date is driven by DWT vs non-tax arbitrage.

Finally, 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). We contribute by not only offering evidence on the direct consequence of stricter enforcement on taxpayer compliance (as the literature did so far, see Slemrod (2019) for a summary), but also examining broader economic consequences of enforcement reform.

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

2.1.1 Dividend Withholding Tax

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

DWT represents a salient cost for investors (e.g., Cooper and Kaplanis, 1994, 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.[7] 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, 2022).

DWT arbitrage strategies have been designed to permit investors to remove such costs or even to exploit the system to turn such costs into excess returns from holding shares in foreign corporations. DWT arbitrage strategies consist in the transfer of shares around the

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

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

dividend record date. Following such a transaction, the right to the dividend is separated from the underlying share. Depending on when the transfer of the ownership of the shares with a dividend entitlement occurs and when the delivery of the shares occurs, such a transaction is known as either a cum-cum or a cum-ex transaction.

In 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 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.[8] 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, tax authorities wrongly assign the ownership of the shares to multiple parties, 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.[9]

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.[10]

The economic rents of cum-cum and cum-ex are shared between lenders and borrowers via the borrowing fee. With regular borrowing fees, the rents of these transactions remain with the borrower (e.g. Collier, 2020). Increases in the borrowing fee indicate rent sharing. In our empirical analysis, we also analyze the extent to which borrowing fees are affected by the presence of cum-cum and cum-ex transactions.

[8] 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).

[9] 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).

[10] Short-sales are also reflected as an increase in the transaction volume of a stock. We use the additional spike in stock market turnover in combination with the German 2012 reform which only targeted cum-ex transactions to quantify the relative importance of cum-cum vs cum-ex in the Online Appendix.

2.2 Danish Reform: Increasing Ownership Information as a Countermeasure

In recent years several EU countries 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 28, 2015. The tax authority launched an action plan to improve the administration of the DWT refund in the Fall of 2015. This resulted in a regulatory change proposed in February 2016, which was approved by the Parliament on June 2, 2016. The new system became effective retroactively on March 17, 2016 and abolished the possibility to apply for a tax refund at source.[11] Instead, dividend income is distributed net of the DWT and a tax refund can be subsequently requested upon the submission of relevant documentation. This includes evidence of beneficial ownership of the shares, 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 legislation in Denmark differs from the anti-arbitrage legislation introduced in Germany in 2016 and in France and Belgium in 2019. In these countries investors can only receive DWT reimbursement if they *hold* the shares for a 45- (in France and Germany) or 60- (in Belgium)-day window around the dividend payment.[12] 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 (if such transactions exist) 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.

2.3 Lending Incentives in the US versus the Nordics

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

[11] See `https://www.ey.com/en_gl/tax-alerts/denmark-proposes-new-withholding-tax-regime-for-dividends`.
[12] Similar legislation is in place in Australia and the US.

US companies and held for at least 60 days.

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

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

Evidence of a temporary reduction in the supply of lendable shares has been documented 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 reform in Denmark. The demand for lending should also strongly increase. We explore this hypothesis in more detail in section 4.2.

3 Data

For our analysis, we collect two types of data. In subsection 3.1 we describe the financial market data with a daily frequency which we use for our analysis on cum-cum and cum-ex transactions. In subsection 3.2 we describe the annual data which we use for our analysis of the welfare consequences of the reform.

3.1 Financial Market Data

Our data on security lending comes from 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 company name. This allows us to match 96% of the Markit data.

Our unit of analysis is the security, since we keep secondary stocks in the event where a company issues two different types of stocks. Note, however, that 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 reform, and inside and outside of the event window. Our main outcome variable is stocks on loan as a percentage of the public float. In addition, we observe the i.) quantity of stocks that are available for lending as a percentage of the public float[13], 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 Data

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

Our data on tax revenue has one caveat. Like most government accounts, the data are collected on a cash-flow basis. As a result, we cannot exclude the possibility that part of reimbursements in a particular year correspond to gross DWT receipts of the previous year. This is particularly apparent in Finland and Norway which both see a spike in reimbursements in 2015 related to previous claims (see Figure A.4 in the Online Appendix). In our analysis, we deal with this 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 should cancel out short-term noise.

Our FPI data stems from the IMF Coordinated Portfolio Investment Survey (CPIS). The CPIS survey collects data at the bilateral level on holdings of portfolio investment assets. We select portfolio investment in the form of equity. Our measure for FPI is the equity holdings of all non-Nordic countries which are continuously in the sample throughout the sample period (see Figure 10 for a full list) into Denmark, Finland, Norway and Sweden. We also consider investment by US fund managers into the Nordics as an additional outcome.

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

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

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

4 The Effect of the Danish Reform on 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 τ 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 $I(t \in k)$ 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 τ in period k. Given that DWT arbitrage schemes should be reflected in the number of stocks on loan, we expect that $\beta_{\tau k} > 0$ for event dates τ close to the ex-dividend date, and in years prior to the reform.

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

4.2 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 spike in Denmark diminishes consistent with the enactment of the reform in mid-2016. After 2016, the evidence for excess lending in Denmark disappears, whereas a spike in lending remains present in the other countries.

Figure 6 plots the coefficients from Figure 5 aggregated by the pre-reform period up to August 2015, the reform period up to June 2016, and the post-reform period, together with a 95-percent confidence interval. Panel A presents the results for Denmark while panel B presents the average of the control group. The figure shows that prior to the reform excess lending is significantly positive. After the reform, the 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.[14] 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 most 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 altered the reimbursement procedure for the DWT, leaving the profitability of other potential arbitrage mechanisms in place. After the reform, the spike in lending disappears entirely, strongly implying 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.

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 6.6 times larger than in the US, consistent with the much stronger incentive for DWT arbitrage in the Nordics than in the US.

[14] 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 capitalisation and dividend yield. Intuitively, since larger companies are more likely to be included in the portfolio of international investors, we expect a stronger effect for larger companies. Additionally, arbitrage is more profitable for shares with a higher dividend yield. Hence, we expect the spike to increase with dividend yield. We present the results for Denmark in Figure 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 capitalisation. The evidence for the highest quartile is consistent with our hypothesis that DWT is most prominent for the largest companies. Specifically, the spikes are not significant for the first quartile, and increase monotonically with the market capitalisation of the underlying firm.

However, in Figure 8, we find no clear pattern with respect to dividend yield. This finding is consistent with the anecdotal evidence that investors engaged in several cum-cum and cum-ex transactions at the same time, making the overall profits from DWT arbitrage high despite the 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); 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, in Denmark 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 We also consider the 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 elavated 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 the rents of cum-cum and cum-ex mainly accrue with to financial intermediaries, rather than with portfolio investors. A potential explanation is that the market for security lending is typically slack giving the borrower more bargaining power than the lender.

Turnover In Figure 9 panel C, we consider whether stock market turnover in Denmark is elevated during the dividend period. Buettner et al. (2019) uses turnover as a measure of cum-ex arbitrage. 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 much more clearly observed in the lending market than in the regular stock market.

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.

5 Welfare Consequences

In this section, we study the welfare consequences to answer the question of whether Denmark has actually benefited from 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. Through stricter enforcement of the DWT on foreign

investors, the government may affect the cost of capital for Danish corporations. 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 here closely mirrors the argument in Desai and Dharmapala (2011) who argue that changes in the DWT rate affect the cost of capital by the same reasoning.

We use the following proxies for the cost of capital for Danish firms. First, we consider whether the reform negatively affects FPI flows into Denmark to evaluate whether it has become more difficult for Danish companies to attract foreign capital. Second, we look at the effect of the reform on Danish stock market returns as a direct measure of the ability of Danish firms to attract capital by issuing equity.

Finally, there exists a large literature that shows that changes in the regular dividend taxes affect dividend pay-out policy (e.g. Chetty and Saez, 2005; Boissel and Matray, 2022). Therefore, in this section we also study whether enforcement of the DWT has similar effects on the dividend policy of Danish firms.

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. Given that tax revenue is only recorded at the country-year level inference has to be conducted on a small sample with only four countries over 10 years. We employ a Synthetic DiD (Arkhangelsky et al., 2021) estimation method. 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).[15]

Panel A in 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 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.

[15]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).

To better understand the mechanism of why tax revenue in Denmark increases 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 Cost of Capital: FPI and stock prices

We proceed by analysing whether the reform has affected the cost of capital of Danish corporations. We consider FPI, as well as returns to Danish stocks. To determine the effect of enforcement on FPI, we rely on bilateral IMF data on equity holdings. We consider equity holdings by non-Nordic fund managers into Danish stocks to a control group of FPI in Finnish, Norwegian and Swedish stocks. We also separate out the effect of US fund managers as an additional outcome. The reason to focus on US investors specifically is that the US is the largest foreign investor in the Nordics that is not covered by EU tax treaties. Our methodology is again Synthetic DiD, since similar to tax revenue, we only have access to aggregate data.

We present results in panels B and C of Figure 10 and Table 4. Surprisingly, equity investment of both overall foreign investors, and US investors in Denmark increased relative to the synthetic control. This effect runs counter to the hypothesis that the reform might increase the cost of capital for Danish firms. However, the increase is not statistically significant as can be seen in Table 4.

An alternative adjustment mechanism is that the investment response is mediated through stock prices. If announcement and/or enactment of the reform results in a drop in Danish stock prices, the lower purchasing price of Danish stocks may compensate for the larger tax and compliance cost. To test this we run a financial event-study around the most relevant reform event dates. In our event-study we make a double comparison. First, we calculate abnormal returns by comparing the return to Danish stocks to an index of Nordic (but not Danish) stocks using a CAPM model. Second, we compare the calculated abnormal returns of Danish firms that pay dividends during our sample period, to those that do not pay dividends during our sample period. The intuition is that only dividend-paying firms are affected by the reform.

Formally, we estimate the CAPM-regression model:

$$R_{it} = \alpha_i + \beta_i R_t^I + \epsilon_{it}, \tag{2}$$

where R_{it} denotes the return on (Danish) stock i at day t, and R_t^I denotes the return on a stock-market index which we created on the basis of all Nordic stocks in our sample that are not listed in Denmark. We estimate (2) on a 120-day window which ends at the beginning of our first event window. We use (2) 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:

$$CAR_{i\tau} = \gamma_\tau + \delta_\tau D_i + \nu_{i\tau}, \tag{3}$$

where $CAR_{i\tau}$ denotes the 3-day cumulative abnormal return and D_i denotes a dummy which equals 1 if the stock has paid dividends during our sample period, and 0 if it has not. We estimate equation (3) using weighted least squares, where we weight observations by the annual market value.

For our events we choose i.) the temporary halting of repayment on August 26, 2015, and ii.) the passing of the reform legislation on June 2, 2016.[16]

Results are presented in Figure 11. There is no noticeable negative stock market response to either of the two reforms.

Our results are slightly surprising in the context of findings in Desai and Dharmapala (2011) and Jacob and Todtenhaupt (2022). Using foreign portfolio investment data, both studies find that changes in the DWT treaty rate between two countries induce a portfolio reallocation to more tax-favourable countries. Given that an increase in DWT enforcement increases the effective DWT rate, one would expect the Danish reform to result in a decrease in FPI.

A potential explanation for the lack of response is that our results in section 4.3 indicate that the majority of rents associated with cum-cum/cum-ex remain with financial intermediaries, rather than (foreign) portfolio investors. In this interpretation, the cost of the reform is not borne by (foreign) portfolio investors, and hence, they do not adjust their portfolios.

5.3 Dividend Policy

Next, we turn to the effect of the reform on dividend policy. For this part of the analysis, we use a Regression-based event-study, rather than synthetic DiD for two reasons. First, for dividends we have company-level data with many treated units, implying that we can rely on standard inference. Second, the regression-method allows us to include industry$\times$ year fixed effects which control for common shocks to specific industries that may affect dividend yield. We estimate the following regression equation:

$$DividendYield_{ijk} = \alpha_i + \eta_{jk} + \beta_k I(i \in Denmark) + \epsilon_{ijk}, \tag{4}$$

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

[16] Results are very similar around the announcement that a reform will happen in September 2015, and when some of the specifics of the reform were announced in February 2016.

available from Compustat. The coefficient of interest is β_k which estimates the DiD between i.) Denmark and the control group, and ii.) year k and the base year.

We plot the results in Figure 12. We find no evidence that post-reform, Danish companies change their dividend policy. This result is somewhat surprising given that there exists evidence that regular dividend taxes affect dividend policy. For instance, Poterba (2004) and Chetty and Saez (2005) find that the US dividend tax cuts in 2003 increased dividend payouts.[17] Jacob and Jacob (2013) provide similar findings on the basis of world-wide data. A potential explanation is that regular dividend taxes apply to all investors. In contrast, the DWT applies only to foreign investors, which are a smaller share for most companies (foreign ownership in EU companies is on average around 21%, see Huizinga and Nicodème (2006)). In addition, in the context of principle-agent concerns (e.g. Chetty and Saez, 2010; Koethenbuerger and Stimmelmayr, 2021) it is noteworthy that the managers of companies are almost certainly not impacted by DWT. Therefore, managers might not be motivated to change their dividend policy when the DWT changes.

Overall, our empirical analysis indicates that the enforcement shock in Denmark strongly increased tax revenue with no evidence of an effect on the cost of capital or dividend policy.

6 Results from other European Countries

In this section, we explore DWT arbitrage and reforms in the remainder of Europe.[18] 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.[19]

With respect to the set of reforms around minimum ownership periods, Germany introduced new legislation on January 1, 2016 according to which a refund for the DWT is granted only if the beneficiary has been the legal and economic owner of the underlying shares for

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

[18] 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 company or authorized intermediary.

[19] 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.

at least 45 days around the dividend record date.[20] 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.[21] In addition, Austria introduced a requirement for the submission of an electronic pre-application for obtaining the refund from a DWT.[22] 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.[23]

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.[24] 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 and in Denmark appear to indicate that both cum-ex and cum-cum may have been illegal even prior to changes in legislation, which could result in penalties and sanctions.[25] As a result, investors may have

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

[21] 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.

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

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

[24] To create these maps we estimate Equation 1 on the number of stocks on loan as a percentage of the public float for each country. We then color-code each country according to the maximum number of excess stocks on loan in the $[-3, 3]$ window.

[25] In this regard, in August 2015, the Danish tax authorities stopped all DWT reimbursements due to alleged tax fraud. While in the same period, in Germany, the fiscal authorities denied for the first time

become more reluctant to participate in DWT arbitrage.

Finally, it is notable that there is evidence of arbitrage in the UK, given that the UK does not levy a DWT. In the Online Appendix Figure A.7, 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 2016 Danish reform in removing the possibility to conduct such tax arbitrage schemes. We confirm such evidence when investigating the effect of similar reforms in other major EU countries. Our welfare analysis provides important insights on the effect of the Danish reform on investor and company behaviour. Post-reform, Denmark experienced a substantial increase in DWT revenues. At the same, Danish companies did not experience a change in cost of capital as visible by the absent stock market reactions to the reform and from the substantially unchanged equity holdings from foreign investors in Denmark. Finally, Danish companies did not change their dividend policy.

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. One could expect the emergence of new channels through which investors will attempt to remove the cost related to DWT. In this regard, expert reports suggest that cum-cum and cum-ex transactions are still occurring.[26] Thus, further governmental action and supranational cooperation is needed to close the tax loopholes and safeguard against tax base erosion.

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

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Figures and Tables

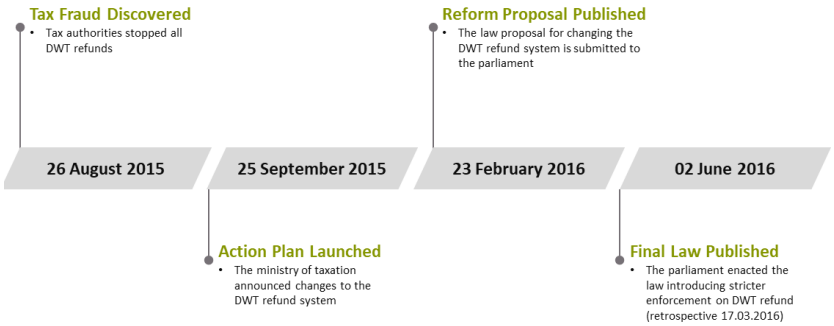


Figure 2: Timeline of the Danish Reform

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

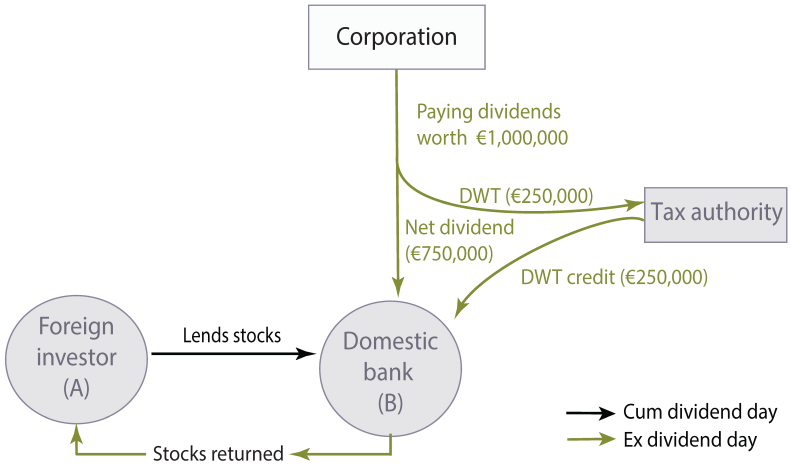


Figure 3: Example of a Cum-Cum Transaction

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.

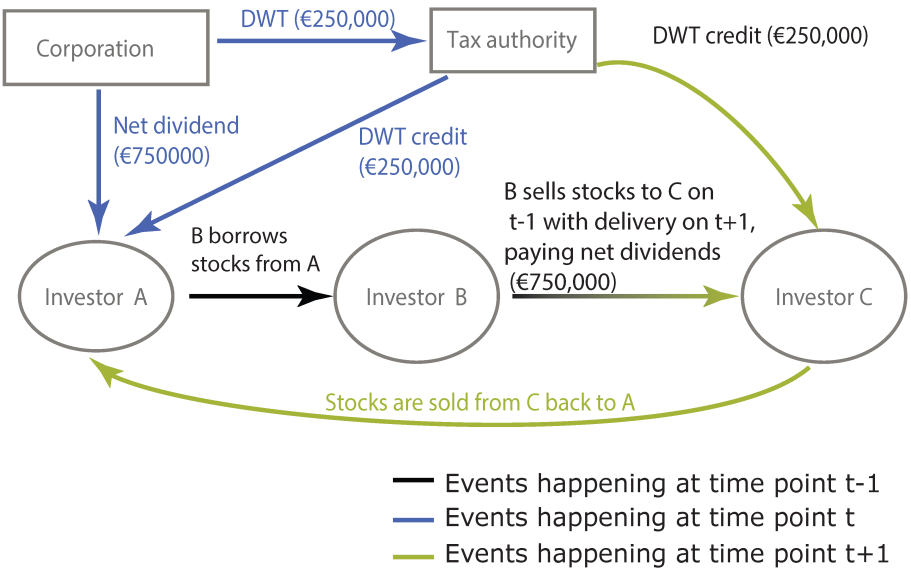
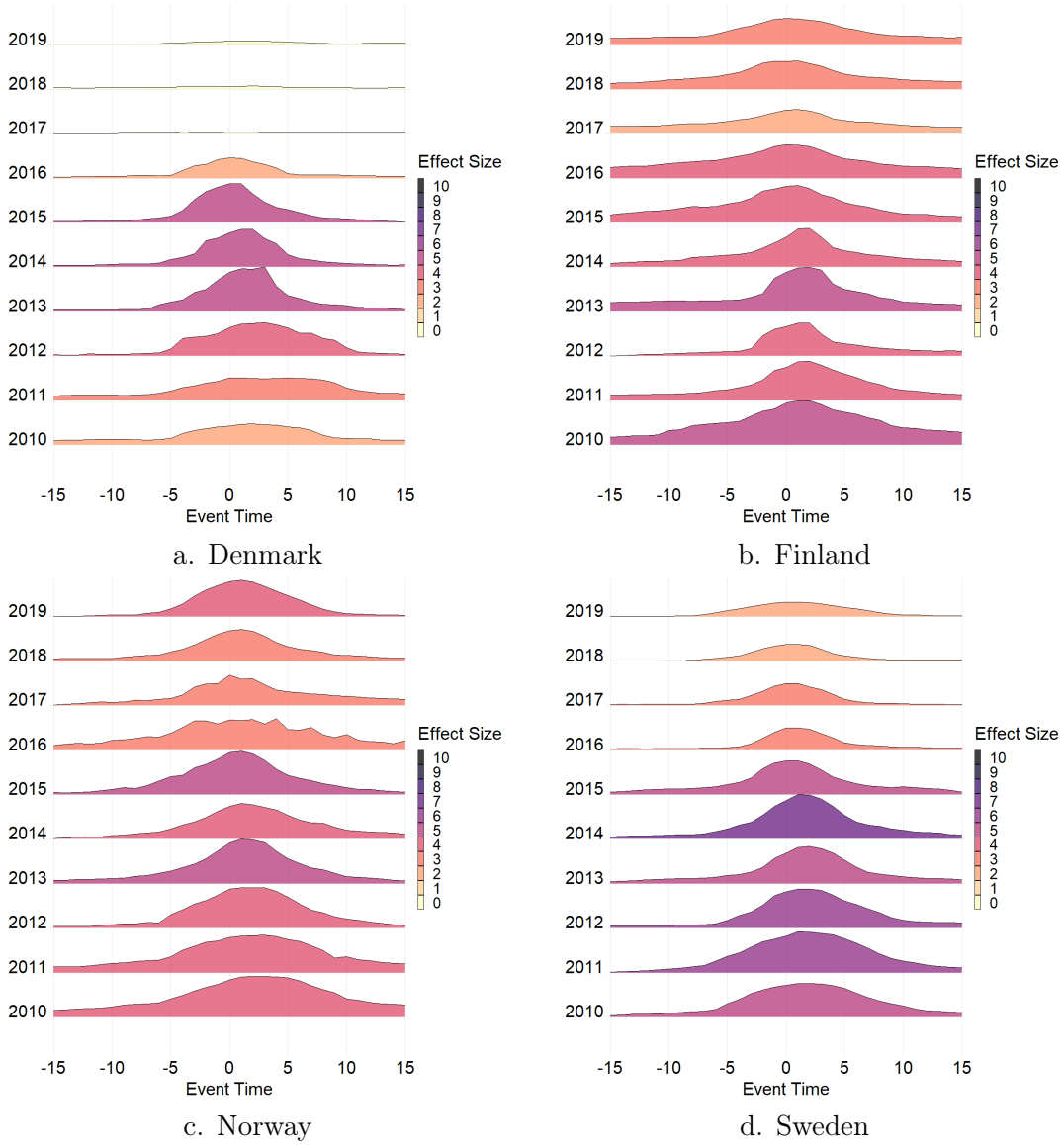


Figure 4: Example of a Cum-Ex Transaction

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



a. Denmark

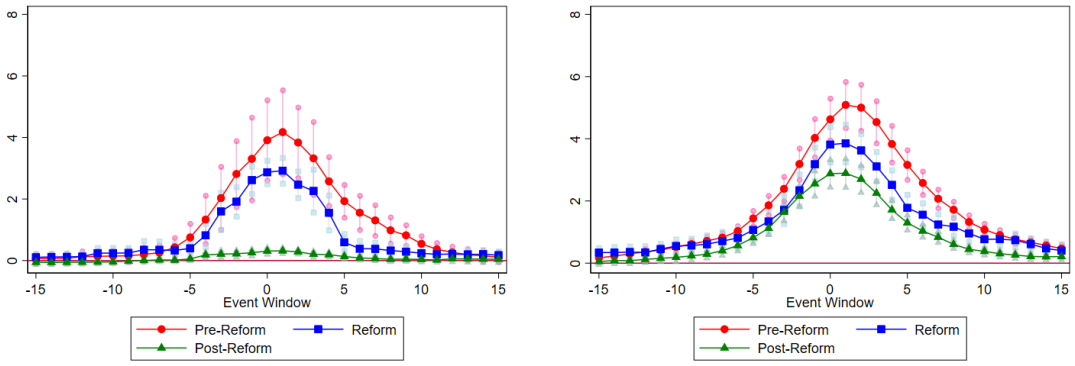
b. Finland

c. Norway

d. Sweden

Notes: The figure plots the excess stocks on loan as a percentage of the public float by event time where $\tau = 0$ is the ex-dividend date. The excess stocks on loan are estimated 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.

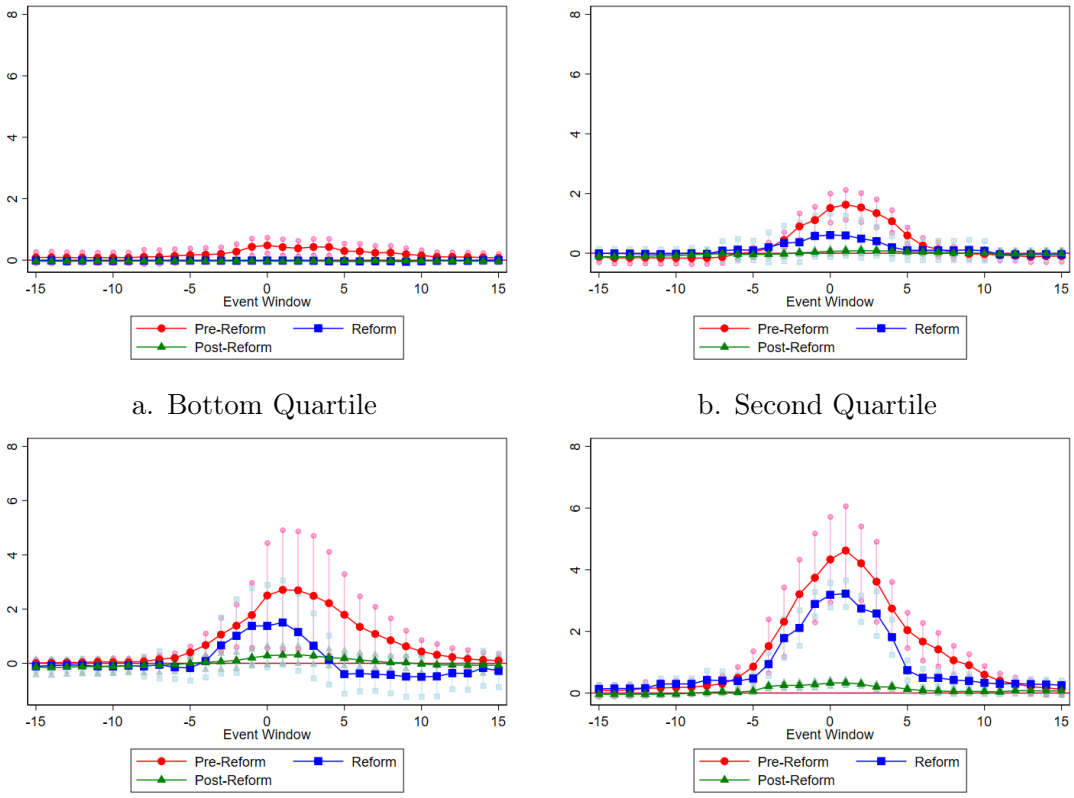
Figure 6: Excess stocks on loan aggregated by the treatment and control group, and treatment and control period



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). Estimates are weighted by annual market capitalisation. Standard errors are clustered at the issuing company level. The resulting β_{tk} are aggregated by i.) treatment group (Denmark)/control group (Finland, Norway and Sweden), and ii.) period: before the reform 2010 up to August 26th 2015, the reform-period from August 26th 2015-June 2nd 2016 and the post-reform period from June 2nd 2016-2019, consistent with the timeline in Figure 2.

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



a. Bottom Quartile

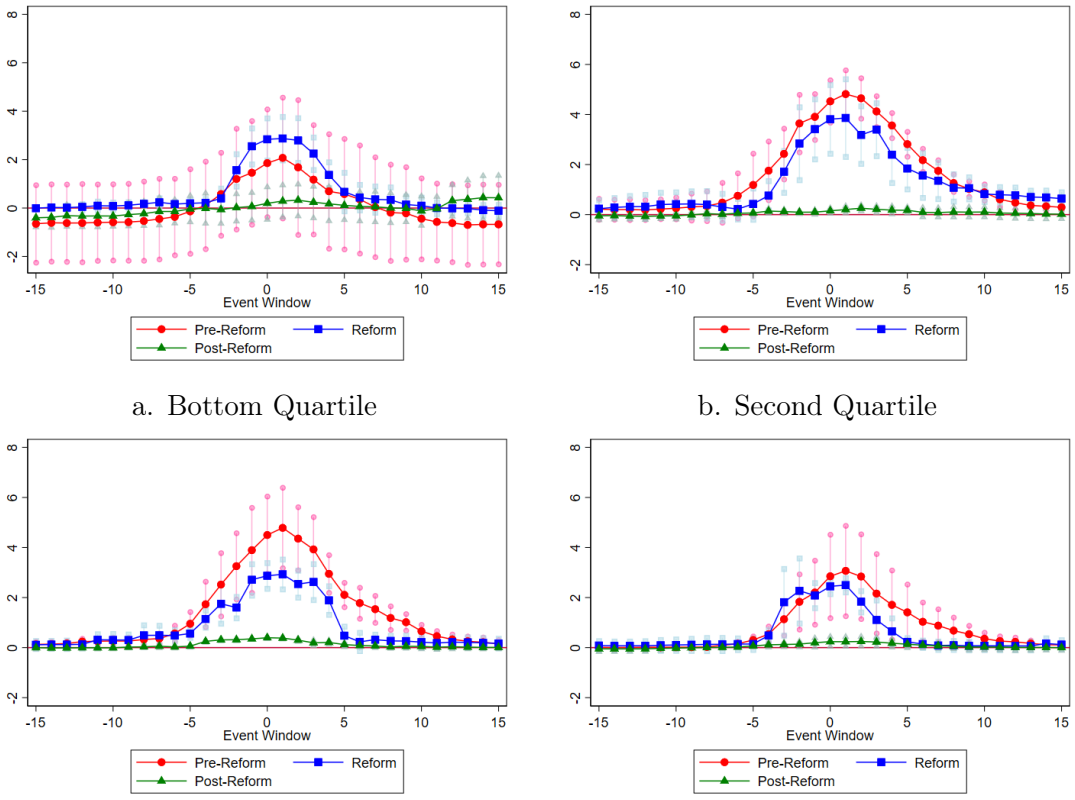
b. Second Quartile

c. Third Quartile

d. Top Quartile

Notes: The figure plots the excess stocks on loan as a percentage of the public float by event time - where $\tau = 0$ is the ex-dividend date - and by quartile of long-term market capitalisation. 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 β_{tk} are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 26th 2015, the reform-period from August 26th 2015-June 2nd 2016 and the post-reform period from June 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

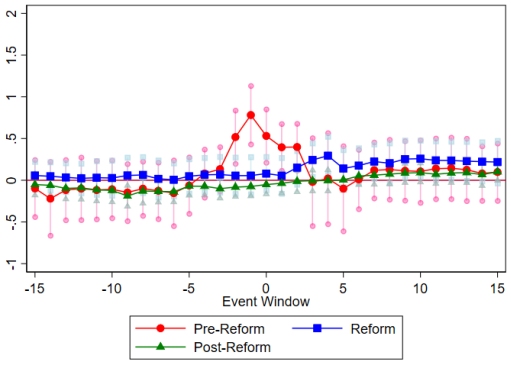
b. Second Quartile

c. Third Quartile

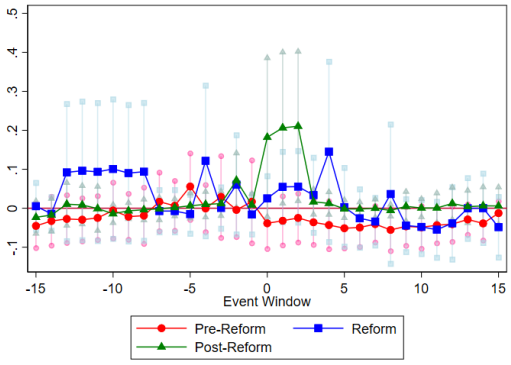
d. Top Quartile

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). Estimates are weighted by annual market capitalisation. Standard errors are clustered at the issuing company level. The resulting β_{tk} are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 26th 2015, the reform-period from August 26th 2015-June 2nd 2016 and the post-reform period from June 2nd 2016-2019, consistent with the timeline in Figure 2.

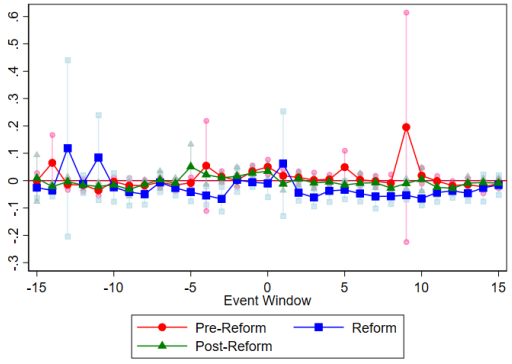
Figure 9: event-study for additional outcome variables for Denmark



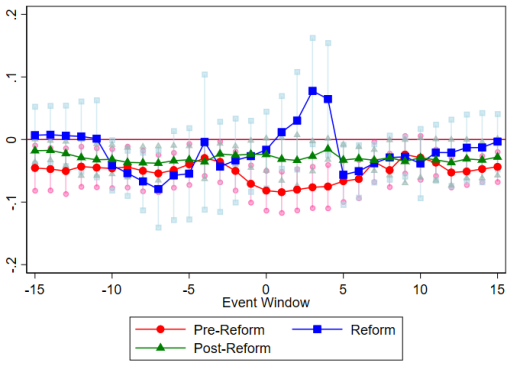
a. Quantity Available for Lending



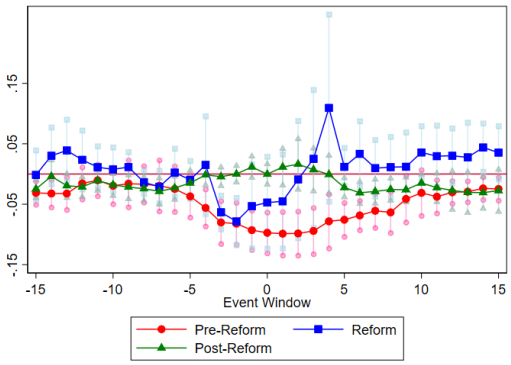
b. Cost of Borrowing



c. Turnover



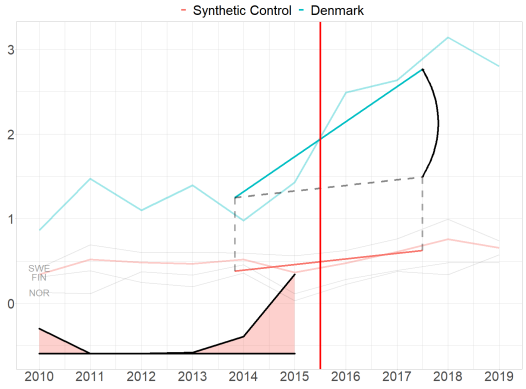
d. Borrower Concentration



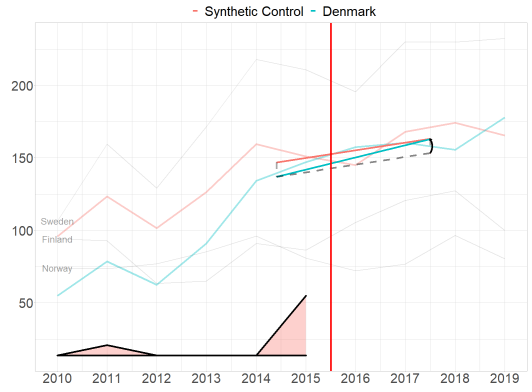
e. Lender Concentration

Notes: The Figure plots the outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each outcome variable is estimated via event-study regression equation (1). Estimates are weighted by annual market capitalisation. Standard errors are clustered at the issuing company level. which we estimate with weighted least squares. We use the annual market capitalisation of a security as regression weights. The resulting β_{tk} are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 26th 2015, the reform-period from August 26th 2015-June 2nd 2016 and the post-reform period from June 2nd 2016-2019, consistent with the timeline in Figure 2.

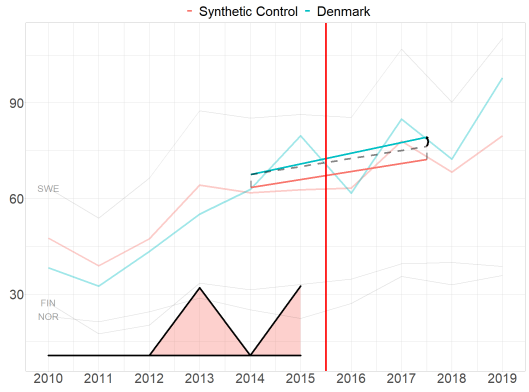
Figure 10: The Effect of the Reform on Net Dividend Withholding Tax Revenue and Foreign Portfolio Investment



a. Net Dividend Withholding Tax Revenue



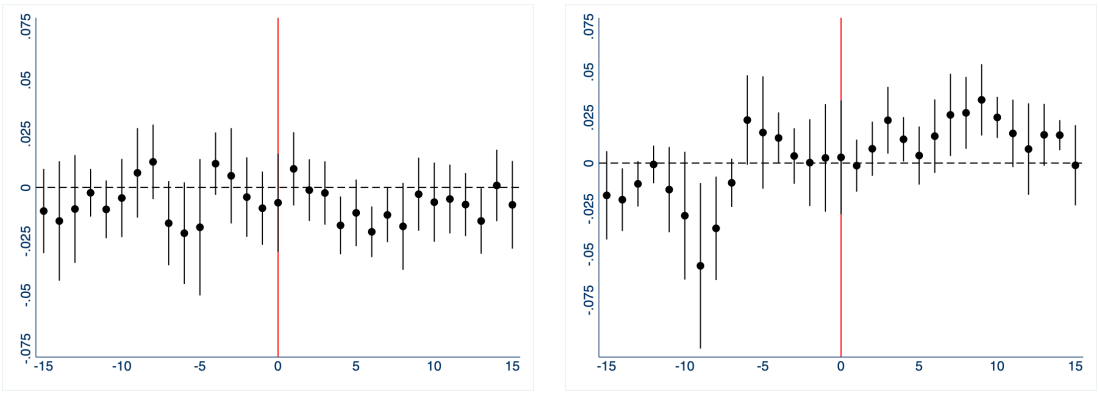
b. Foreign Portfolio Investment



c. Portfolio Investment from US

Notes: The figure shows the causal effect of the Danish reform on the dependent variable in the title of each panel 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. All dependent variables are denominated in billions USD. The blue line in panels b. and c. represents annual portfolio investments by, respectively fund managers of all countries with no missing observations (Argentina, Austria, Belgium, Bermuda, Brazil, Bulgaria, Canada, Chile, Hong Kong, Macao, Colombia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Guernsey, Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Jersey, Kazakhstan, Korea, Lebanon, Luxembourg, Malaysia, Mongolia, the Netherlands, Palau, Portugal, Slovenia, South Africa, Sweden, Switzerland, Turkey, United Kingdom, United States, Uruguay, Venezuela) into Denmark (panel b) and US fund managers into Denmark (panel c). The treatment begins in 2016. Table 4 contains the set of synthetic weights, and quantifies the causal effect.

Figure 11: Effect of the Reform on Danish Stock Returns



a. 26 August 2015 b. 02 June 2016

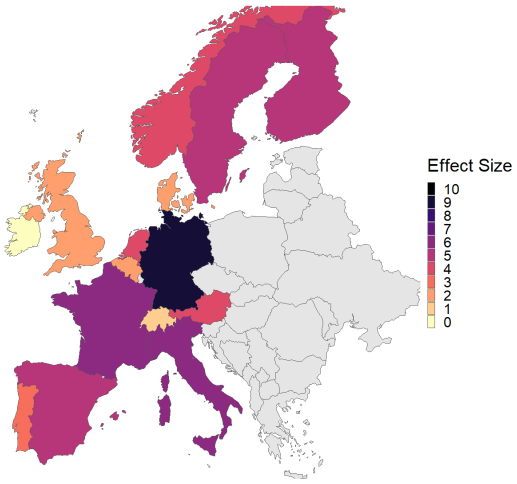
Notes: The figure plots the difference in 3-day cumulative abnormal returns for i.) Danish dividend-paying stocks, and ii.) Danish non-dividend-paying stocks around the event-windows centered at the date listed in the caption (coefficients δ_τ in (3)). The dates are explained in the timeline in Figure 2. Cumulative abnormal returns are estimated on the basis of CAPM-model (2), which compares the return of Danish stocks to an index of Nordic stocks that excludes Denmark. Error-bars represent a 95 % confidence interval. Standard errors are clustered at the company level.

Figure 12: The Effect of the Reform on Dividend Policy

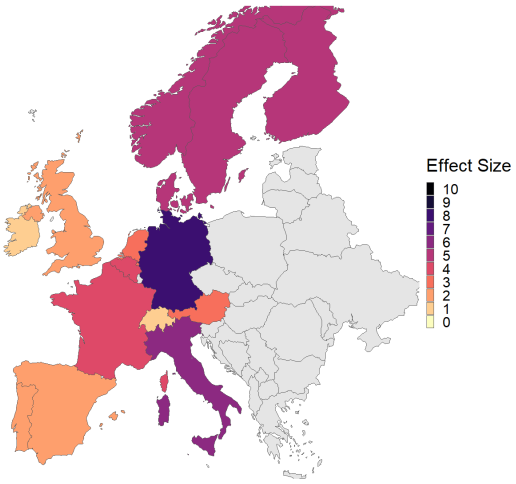
a. I(Dividends)>0 b. Dividend Yield

Notes: The figure shows an event-study on the difference between i.) Denmark and ii.) Finland, Norway and Sweden . The outcome variables are in panel a.) the probability of a company paying dividends, and in panel b.) dividend yield. Coefficients are estimated with regression equation (4). Estimates are weighted by annual market capitalisation. Standard errors are clustered at the issuing company level.

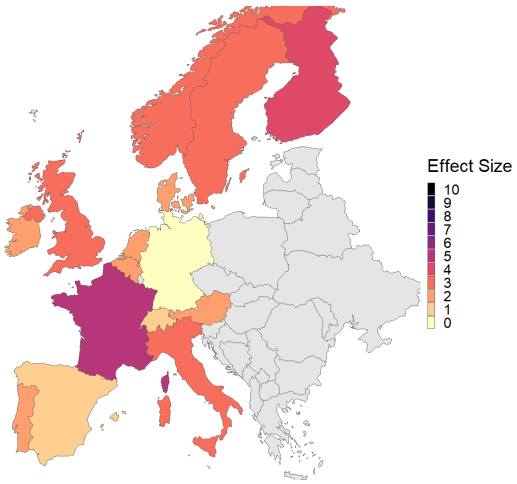
Figure 13: Excess stocks on loan in 15 European countries



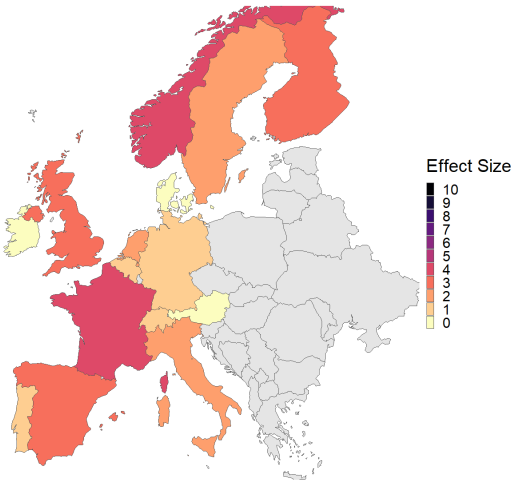
a. 2010



b.2013



a. 2016



b.2019

Notes: The map 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 $\tau \in [-3, 3]$ by country and year. Estimates are weighted by annual market capitalisation. Standard errors are clustered at the company 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	4.109	1.172	5.558	3.457	4.360	3.595	6.131	3.709	1.280
	(2.278)	(1.309)	(3.504)	(2.281)	(2.434)	(2.286)	(3.674)	(2.500)	(1.938)
Stocks Available for Lending	14.93	16.70	13.88	14.42	9.416	10.41	17.23	15.64	14.48
	(6.431)	(5.974)	(7.320)	(7.739)	(4.376)	(5.489)	(8.201)	(6.490)	(6.988)
Turnover	0.232	0.200	0.390	0.237	0.252	0.170	0.385	0.301	0.253
	(0.193)	(0.145)	(0.386)	(0.189)	(0.287)	(0.151)	(0.352)	(0.257)	(0.408)
Cost of Borrowing	1.178	1.235	1.499	1.162	1.307	1.147	1.403	1.232	1.235
	(0.751)	(0.949)	(1.513)	(0.830)	(1.127)	(0.692)	(1.270)	(0.934)	(0.814)
Lender Concentration	0.168	0.257	0.217	0.218	0.168	0.184	0.203	0.236	0.253
	(0.156)	(0.182)	(0.192)	(0.188)	(0.161)	(0.156)	(0.174)	(0.184)	(0.188)
Borrower Concentration	0.228	0.242	0.176	0.214	0.160	0.244	0.198	0.234	0.257
	(0.168)	(0.142)	(0.170)	(0.184)	(0.160)	(0.133)	(0.167)	(0.161)	(0.169)
Number of Events	203	159	346	206	293	253	839	790	0
Observations $[-3, +3]$	1342	1117	2248	1402	1912	1675	5410	5164	753193
Observations $[-15, +15]$	5861	4967	9772	6170	8427	7472	23417	22624	753193

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 June 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 capitalisation. Standard deviations are in parenthesis.

Table 3: Summary Statistics Annual Data

	Denmark		Finland		Norway		Sweden		Obs.
	Before	After	Before	After	Before	After	Before	After	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Net DWT Revenue	1206.8	2768.8	254.7	377.7	250.8	408.9	578.8	780.9	40
	(259.0)	(279.3)	(128.4)	(145.6)	(155.3)	(93.31)	(89.68)	(155.3)	
% Reimbursements	36.17	20	31.67	28.25	42.50	17.75	26.17	20.00	40
	(17.22)	(0.816)	(29.49)	(14.86)	(22.30)	(3.775)	(9.326)	(7.439)	
US Portfolio Investment	51934.1	79208.5	27129.9	38191.8	24120.7	32843	73753.5	98160	40
	(17519.3)	(15680.1)	(6816.9)	(2379.3)	(2625.6)	(4077.0)	(14428.3)	(12176.1)	
Foreign Portfolio Investment	114822.9	162363.0	85113.3	114957.2	72412.8	80555.9	193866.1	218096.9	40
	(33934.3)	(13504.4)	(12469.2)	(11044.4)	(8908.2)	(10381.3)	(31464.0)	(16997.4)	
Dividend Yield	0.0176	0.0216	0.0400	0.0377	0.0380	0.0336	0.0338	0.0301	3129
	(0.0121)	(0.0115)	(0.0190)	(0.0240)	(0.0199)	(0.0188)	(0.0163)	(0.0191)	
I(Dividends)>0	0.903	0.936	0.941	0.860	0.922	0.916	0.941	0.928	3129
	(0.297)	(0.246)	(0.235)	(0.348)	(0.269)	(0.278)	(0.236)	(0.259)	

Notes: The table presents summary statistics for the variables used in the analysis. The columns Before refer to the period from 2010 to 2015. The columns After refers to the period from 2016-2019, 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. US Portfolio Investments represents the amount of investment in the Nordic countries by all US fund managers. Foreign Portfolio Investment represents the amount of investment in the Nordic countries by all fund managers residents from all countries with non-missing values, see notes to Figure 10 for a list. Dividend Yield is the average annual dividend yield by company. I(Dividends)>0 is an indicator variable equal to one if a company pays dividend in year t. The statistics for Dividend yield and I(Dividends) are weighted by market capitalisation. Standard deviations are in parenthesis.

Table 4: Synthetic Difference-in-Difference

		Foreign Portfolio Investment From	
	Net DWT Revenue	All Countries	US
	(1)	(2)	(3)
Panel A. Causal Effect			
SDiD Denmark	1.272***	9.677	2.845
	(0.021)	(53.494)	(6.000)
Panel B. Synthetic Weights			
Finland	0.212	0.225	0.318
Norway	0.188	0.244	0.105
Sweden	0.600	0.530	0.576

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

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.[27] 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.[28]

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.[29]

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

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

[28] 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.

[29] 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.[30]

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.[31] 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.5. As can be seen, the results in Figure A.5 are virtually identical to our main result in Figure 6 which includes DRIP events .

[30]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.

[31]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.[32]

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.6 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.

[32] 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.[33]

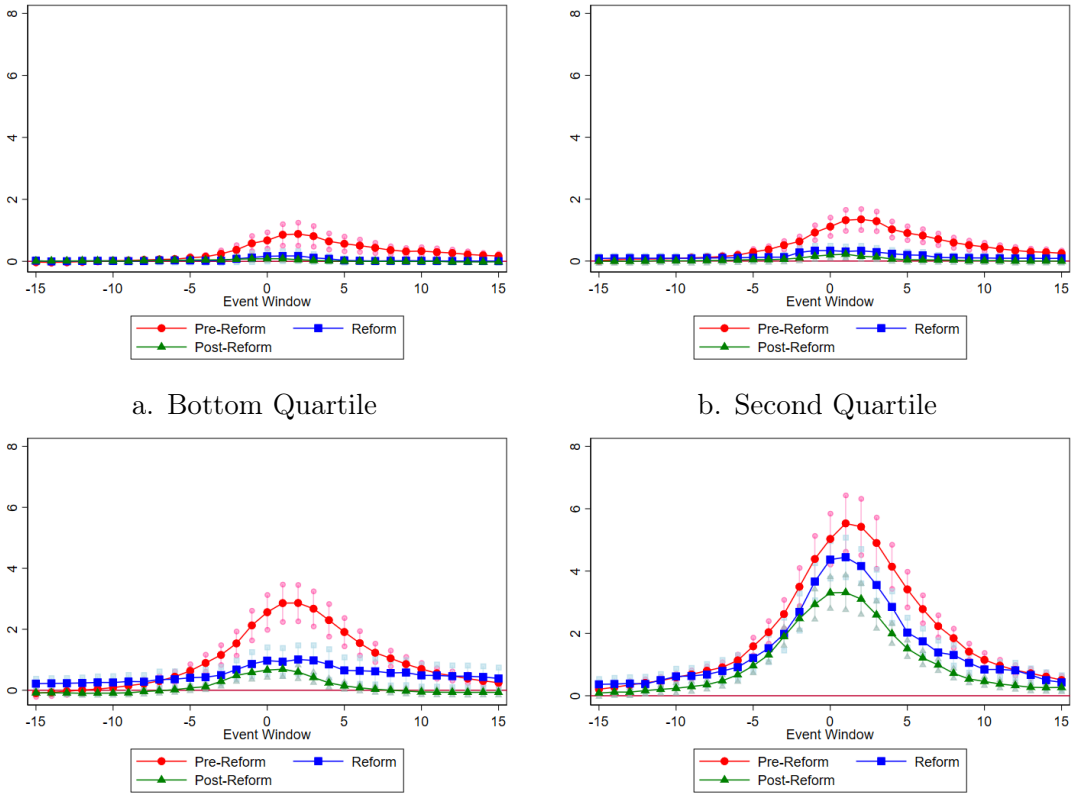
Figure A.7 plots the result for both specifications. We replicate the finding of the ESMA by showing that there is indeed a significant increase in stock lending around the ex-dividend

[33]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

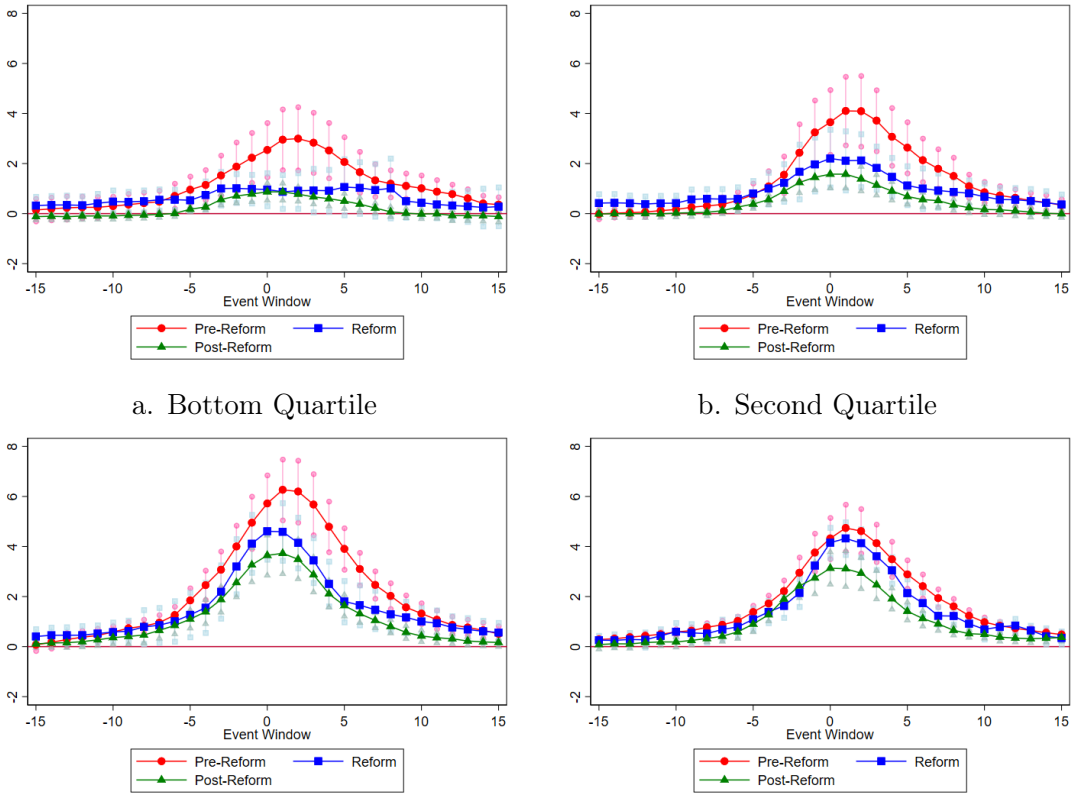
b. Second Quartile

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 β_{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 - June 2nd 2016) and the post-reform period (June 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

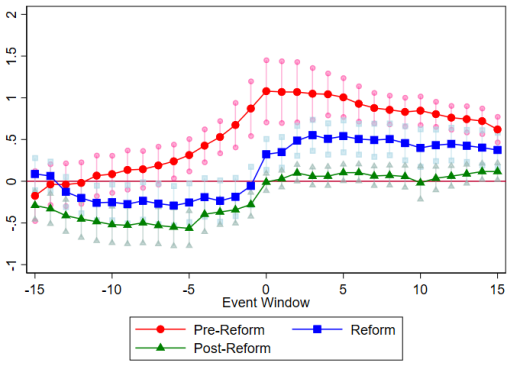
b. Second Quartile

c. Third Quartile

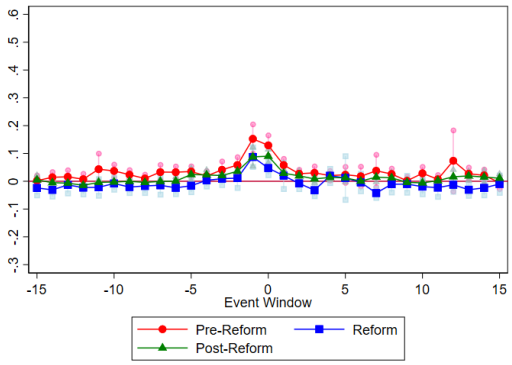
d. Top Quartile

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 β_{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 - June 2nd 2016) and the post-reform period (June 2nd 2016-2019), consistent with Figure 2. Standard errors are clustered at the issuing company level.

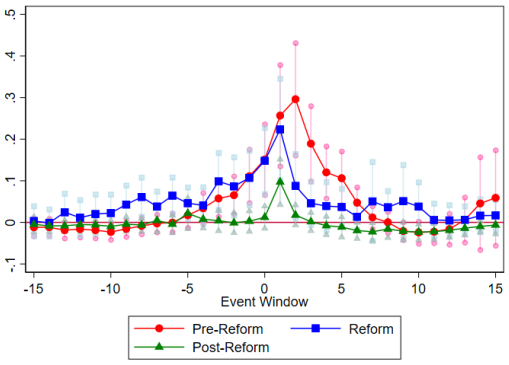
Figure A.3: Event study for additional outcome variables for the control group



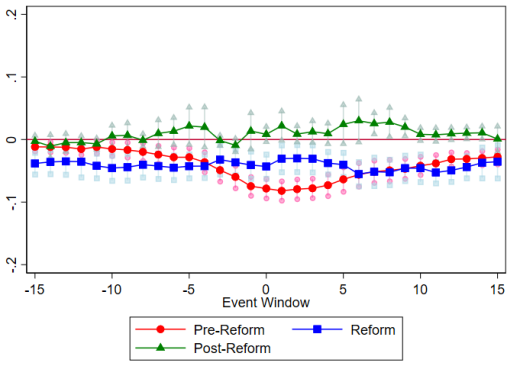
a. Quantity Available for Lending



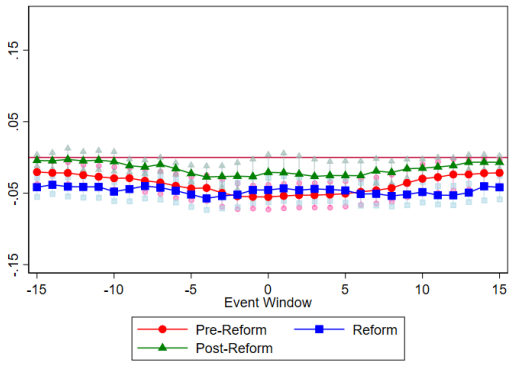
b. Turnover



c. Cost of Borrowing



d. Borrower Concentration



e. Lender Concentration

Notes: The Figure plots the outcome variable as listed in the caption by event time where $\tau = 0$ is the ex-dividend date. Each outcome variable is estimated via event study regression equation (1). Estimates are weighted by annual market capitalization. The resulting β_{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 - June 2nd 2016) and the post-reform period (June 2nd 2016-2019), consistent with Figure 2. Standard errors are clustered at the issuing company level.

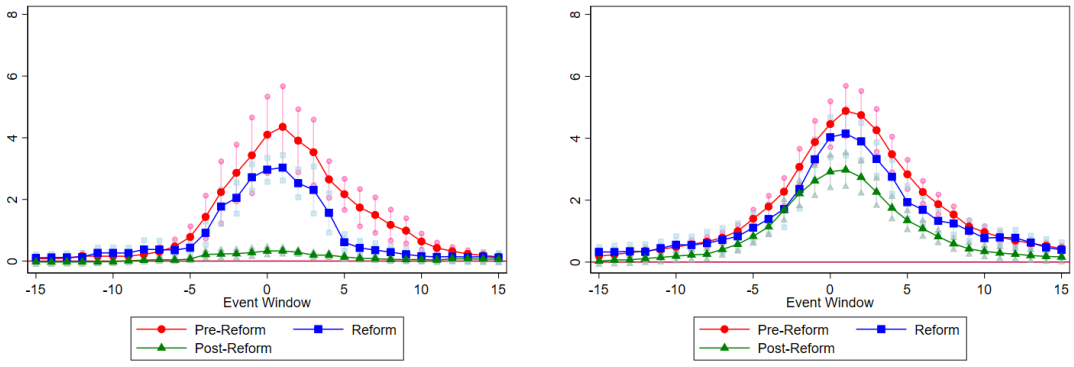
Figure A.4: Net DWT revenue and reimbursements

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.

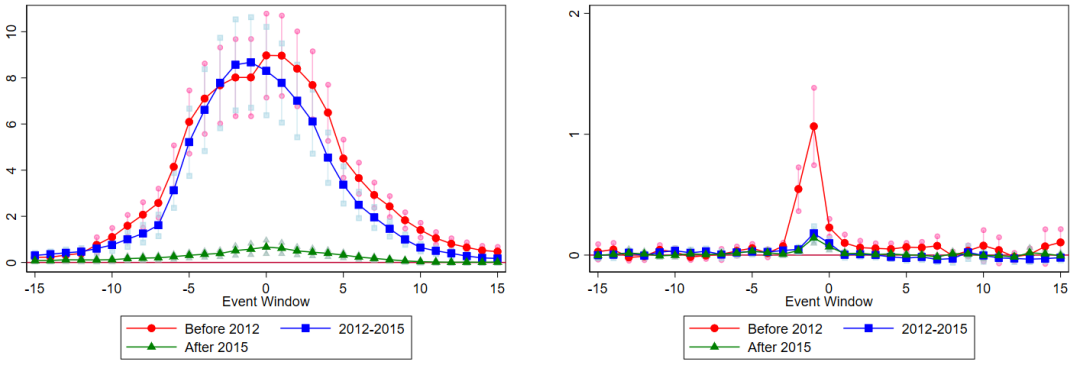
Figure A.5: Event Study Excluding Dividend Distributions with DRIP



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 β_{tk} are aggregated by treatment group (Denmark), and ii.) period: before the reform 2010 up to August 26th 2015, the reform-period from August 26th 2015-June 2nd 2016 and the post-reform period from June 2nd 2016-2019, consistent with the timeline in Figure 2.

Figure A.6: Germany

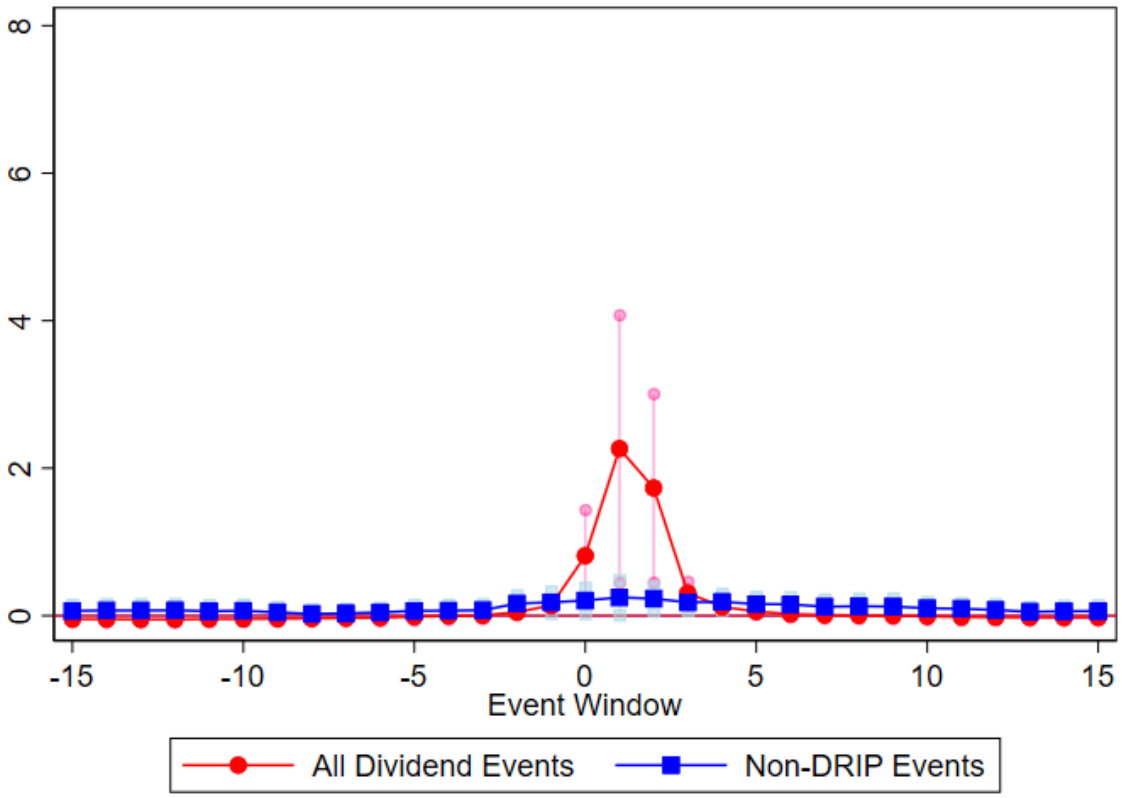


a. Excess Stocks on Loan

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 β_{tk} are aggregated by i.) treatment group (Germany), and ii.) period: before the 2012 reform (2010-2011), after the 2012 reform and before the 2016 reform (2012-2015) and the post-reform period (2016-2019). Standard errors are clustered at the issuing company level.

Figure A.7: UK



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

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	4.109	3.255	1.172	5.558	5.448	3.457	4.360	5.000	3.595	6.131	4.147	3.709	1.280
	(2.278)	(1.713)	(1.309)	(3.504)	(2.635)	(2.281)	(2.434)	(2.775)	(2.286)	(3.674)	(2.798)	(2.500)	(1.938)
Stocks Available for Lending	14.93	16.24	16.70	13.88	16.97	14.42	9.416	11.94	10.41	17.23	14.64	15.64	14.48
	(6.431)	(5.975)	(5.974)	(7.320)	(6.970)	(7.739)	(4.376)	(4.650)	(5.489)	(8.201)	(6.790)	(6.490)	(6.988)
Turnover	0.232	0.198	0.200	0.390	0.264	0.237	0.252	0.192	0.170	0.385	0.288	0.301	0.253
	(0.193)	(0.262)	(0.145)	(0.386)	(0.196)	(0.189)	(0.287)	(0.207)	(0.151)	(0.352)	(0.333)	(0.257)	(0.408)
Cost of Borrowing	1.178	1.186	1.235	1.499	1.335	1.162	1.307	1.315	1.147	1.403	1.433	1.232	1.235
	(0.751)	(0.824)	(0.949)	(1.513)	(1.137)	(0.830)	(1.127)	(0.966)	(0.692)	(1.270)	(1.211)	(0.934)	(0.814)
Lender Concentration	0.168	0.196	0.257	0.217	0.191	0.218	0.168	0.165	0.184	0.203	0.196	0.236	0.253
	(0.156)	(0.151)	(0.182)	(0.192)	(0.216)	(0.188)	(0.161)	(0.136)	(0.156)	(0.174)	(0.177)	(0.184)	(0.188)
Borrower Concentration	0.228	0.335	0.242	0.176	0.211	0.214	0.160	0.185	0.244	0.198	0.245	0.234	0.257
	(0.168)	(0.185)	(0.142)	(0.170)	(0.187)	(0.184)	(0.160)	(0.152)	(0.133)	(0.167)	(0.175)	(0.161)	(0.169)
Observations $[-3, +3]$	1342	270	1117	2248	353	1402	1912	287	1675	5410	1135	5164	753193
Observations $[-15, +15]$	5861	1201	4967	9772	1553	6170	8427	1311	7472	23417	4958	22624	753193
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-June 2nd 2016. The columns After refers to the period from June 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.

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