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INCOME SHIFTING IN THE ERA OF DIGITALIZATION AND TAX INDUCED CAPITAL MARKET REACTIONS

Income Shifting in the Era of Digitalization and Tax Induced Capital Market Reactions

Inauguraldissertation zur Erlangung des akademischen

Grades eines Doktors der Wirtschaftswissenschaften der

Universität Mannheim

vorgelegt von

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Mannheim

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Tag der mündlichen Prüfung:	10. Dezember 2021

ACKNOWLEDGEMENTS

I am deeply grateful to all those who supported and accompanied me during my doctoral studies at the University of Mannheim and the ZEW Mannheim.

My sincerest thanks go to my supervisor Christoph Spengel for his outstanding support and exceptional supervision. His inspiring personality and enthusiasm create a highly creative and productive atmosphere to address relevant research questions in business taxation. His tireless commitment to socially highly relevant topics, his caring dedication to his team, and his unique commitment to the students of the University of Mannheim are role models for me.

Furthermore, I am very grateful to Jannis Bischof and Philipp Dörrenberg for taking on the co-supervision of my dissertation and their very valuable advice and comments. In addition, I thank Johannes Voget for sharpening my understanding of empirical research. Likewise, I thank Friedrich Heinemann for his support and the freedom he gave me in my research projects.

Moreover, I thank my co-authors, Verena Dutt, Daniel Klein, Katharina Nicolay, Christoph Spengel, Heiko Vay, and Johannes Voget, for their incredible dedication to our joint research projects. In particular, I thank Katharina Nicolay for sparking my interest in pursuing a PhD. I am incredibly thankful to Daniel Klein for our very intense research time, inspiring conference visits, and countless in-depth conversations. As a co-author and friend, he has analyzed many topics with me from different angles.

I would also like to thank the entire team at the University of Mannheim and the ZEW Mannheim for our strong cohesion and friendship. It truly is an honor to be part of this team. In particular, I would like to thank Raphael Müller for always keeping the students' interests in mind with me, and Daniela Steinbrenner for being a perfect office mate. I also thank Julia Spix, my excellent student assistant.

Indescribable thanks go to my parents, Stephanie Silberberg-Ludwig and Elmar Ludwig, who always encourage me and support me throughout my life. I am equally grateful to my siblings, Sebastian Ludwig and Viktoria Ludwig, who inspire me profoundly and whose perspectives I value greatly. Infinite thanks go to my wonderful wife Nina, who accompanies my life in every aspect, inspires me every day, and always supports and encourages me.

Mannheim, September 2021 *Christopher Ludwig*

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LIST OF ABBREVIATIONS

Adj	adjusted
Apr	April
AR	abnormal return
ATE	average treatment effect
Aug	August
B2B	Business-to-Business
B2C	Business-to-Consumer
BEPS	Base Erosion and Profit Shifting
BHR	buy-and-hold return
BMD3	3rd edition of the benchmark definition of FDI
BMD4	4th edition of the benchmark definition of FDI
CAAR	cumulative average abnormal return
CbCR	Country-by-Country reporting
CEO	Chief Executive Officer
CFE	Confédération Fiscale Européenne
CIT	corporate income tax
CiTDB	Computer Intelligence Technology Database
CRD IV	Capital Requirements Directive IV (Directive 2013/36/EU)
CRR	Capital Requirements Regulation (Regulation (EU) No 575/2013)
DBMS	database management systems
Dec	December
DFG	German Research Foundation (Deutsche Forschungsgemeinschaft)
DOF	degrees of freedom

DST	Digital Services Tax
e.g.	exempli gratia (for example)
EBIT	earnings before income and taxes
EC	European Commission
ECB	European Central Bank
ECOFIN	The Economic and Financial Affairs Council
EITI	Extractive Industries Transparency Initiative
ERP	enterprise resource planning
et al.	et alii (and others)
ETPF	European Tax Policy Forum
ETR	effective tax rates
EU	European Union
EUR	Euro
FDI	foreign direct investment
Feb	February
FF-HML Factor	Fama-French High-Minus-Low Factor
FF-SMB Factor	Fama-French Small-Minus-Big Factor
GDP	gross domestic product
GUO	global ultimate owner
HQ	headquarter
i.a.	inter alia (amongst others)
ID	identification number
i.e.	id est (that is)
IFAS	intangible fixed assets
IP	intellectual property

IT	information technology
Jan	January
Jul	July
log	logarithm
Mar	March
Max	Maximum
Min	Minimum
MNEs	multinational enterprises
N	number of observations
NACE	statistical classification of economic activities in the European Community
NBER	National Bureau of Economic Research
NGO	non-governmental organization
No	number
NTA	National Tax Association
Oct	October
OECD	Organization for Economic Cooperation and Development
p.	page
P25	25th percentile
P75	75th percentile
PLBT	profit and loss before tax
PROD	productivity
PV	present value
p-value	probability value
R&D	research and development
R2	coefficient of determination

RI	return index
RoA	return on assets
SD	standard deviation
Sec.	Section
Sep	September
SPEs	special purpose entities
STAF	employee compensation
TFAS	tangible fixed assets
TIEA	Tax Information Exchange Agreements
TOAS	total assets
TRR	collaborative research centre
U.S.	United States (of America)
UAE	United Arabic Emirates
UIS.Stat	UNESCO Institute for Statistics
UK	United Kingdom
UNESCO	United Nations Educational Social Cultural Organization
USD	United States Dollar
VoI	variable of interest
WSJ	Wall Street Journal
ZAR	South African Rand
ZEW	Center for European Economic Research

1. Introduction

The increasing global dispersion of business activities and new forms of value creation – driven by the ongoing globalization and digitalization of the economy – corroborate the long-standing apprehension of policymakers that tax base erosion and income shifting pose a risk to national tax revenues (OECD, 2013b, 2015a, 2018, 2020a). In light of current reform proposals to fundamentally change the system of international corporate taxation, it is of high relevance for the political and academic debate to understand how tax-induced cross-border income shifting has evolved in the era of digitalization and how measures to safeguard tax revenues and to prevent income shifting affect firms. This dissertation contributes to this debate along the line of three central questions:

(1) How large is the extent of base erosion and profit shifting (BEPS) and how has BEPS evolved?

(2) To what extent has the digital transformation corroborated the ability of multinational corporations to engage in cross-border income shifting?

(3) How do key stakeholders of multinational firms evaluate reform proposals to safeguard tax revenues and to counteract BEPS?

This dissertation addresses these questions in self-contained sections that are based on four individually written research papers. The research papers have been originally prepared as submissions for publication in academic journals and are the work of multiple authors. Table 1 lists the papers included in this dissertation, depicts their current publication status, acknowledges the different co-authors and highlights my key contributions.

Section 2 is based on the paper "Quantifying the OECD BEPS Indicators – An update to BEPS Action 11", co-authored with Daniel Klein, Katharina Nicolay and Christoph Spengel. The second section addresses the first central question of this dissertation. The study revisits three selected indicators of the six in 2015 introduced OECD indicators to quantify and evaluate

Table 1: Co-authors and publication status of papers

Sec.	Paper	Co-authors	Publication status	Own key contribution
2	Quantifying the OECD BEPS Indicators – An Update to BEPS Action 11	Daniel Klein Katharina Nicolay Christoph Spengel	ZEW Discussion Paper No. 21-013 (prepared for a submission)	• Introduction and positioning of the paper • Literature survey • Data collection and preparation • Econometric analysis including regression analysis and propensity score matching • Interpretation of results • Critical evaluation of indicators • Summary of the results and policy recommendations
3	Internal Digitalization and Tax-Efficient Decision Making	Daniel Klein Katharina Nicolay	ZEW Discussion Paper No. 20-051 (prepared for a submission)	• Introduction and positioning of the paper • Literature survey • Development of hypotheses • Data collection • Combination of survey data and financial data • Econometric analysis including regression analysis, instrumental variables approach and robustness checks • Interpretation of results • Conclusion
4	Increasing Tax Transparency: Investor Reactions to the Country-by-Country Reporting Requirement for EU Financial Institutions	Verena Dutt Katharina Nicolay Heiko Vay Johannes Voget	Published in International Tax and Public Finance	• Positioning of the paper • Data collection and preparation • Econometric analysis including event study approach, cross-sectional tests and robustness checks • Interpretation of results
5	Taxing the Digital Economy: Investor Reactions to the European Commission's Digital Tax Proposals	Daniel Klein Christoph Spengel	ZEW Discussion Paper No. 19-050 (accepted at National Tax Journal)	• Introduction and positioning of the paper • Literature survey • Development of hypotheses • Data collection • Econometric analysis including regression analysis, event study approach and robustness checks • Interpretation of results • Summary of the results and conclusion

BEPS over time. First, my co-authors and I transparently replicate Indicator 1, which intends to assess the disconnect between financial and real economic activities and we show a moderately decreasing trend of the indicator estimates. Second, replicating Indicator 4, we find that multinational firms have, on average, lower effective tax rates than domestic firms. We confirm this result using a state-of-the-art propensity score matching approach. Third, the

replication of Indicator 5, which intends to capture profit shifting through intangibles, shows a stable trend of the annual indicator estimates that extends beyond the OECD's sample period. Overall, the study in section 2 leads to the conclusion that the proposed indicators in the Final Report on BEPS Action 11 provide only limited information on the extent of BEPS.

Section 3 is based on the paper "Internal Digitalization and Tax-efficient Decision Making", co-authored with Daniel Klein and Katharina Nicolay. The third section addresses the second central question of this dissertation. The study investigates the effect of firms' internal digitalization on tax-induced cross-border income shifting. My co-authors and I put forward a novel, micro-level digitalization index based on a survey monitoring European firms' digital infrastructure. Our index captures if firms have implemented up to three key software solutions to digitally monitor and manage firm performance: Enterprise resource planning (ERP) software, database management systems (DBMS) and groupware software. We show that internal digitalization boosts tax-induced cross-border income shifting. We find that communication between firms via groupware software seems to be a key enabler of organizations' tax planning strategies. We instrument for the investment in digitalization to mitigate potential endogeneity concerns and show that digitalized firms promptly adjust reported profits in response to income shifting incentive shocks. Overall, our findings suggest that digital infrastructure is a crucial foundation for timely, data-driven decision making in tax departments of multinational firms and increases support functions' performance in terms of tax-induced cross-border income shifting.

Section 4 is based on the paper "Increasing Tax Transparency: Investor Reactions to the Country-by-Country Reporting Requirement for EU Financial Institutions", co-authored with Verena Dutt, Katharina Nicolay, Heiko Vay and Johannes Voget. The fourth section addresses the third central question of this dissertation. The study employs an event study methodology to investigate the capital market reaction to the surprising political decision to adopt a public country-by-country reporting (CbCR) obligation for European Union financial institutions. The

results suggest a zero response in our full sample of financial institutions headquartered in the European Union. My co-authors and I conduct several sample splits and find that the investor reaction is slightly more negative for banks engaging in selected tax havens and banks with an above-average business to consumer orientation and slightly more positive for banks with a below-average share of institutional investors. We conclude that investors anticipated a simultaneous reduction in banks' tax avoidance opportunities and information asymmetries between managers and shareholders, implying both negative and positive stock price reactions that offset each other on average. We relate our findings to previous studies on the introduction of similar tax transparency measures and contend that capital market reactions to increases in tax transparency depend crucially on the exact design and objective of the initiative.

Section 5 is based on the paper "Taxing the Digital Economy: Investor Reactions to the European Commission's Digital Tax Proposals", co-authored with Daniel Klein and Christoph Spengel. The fifth section also addresses the third central question of this dissertation. The study analyzes investor reactions to the European Commission's proposals on the taxation of digital firms. Examining the stock returns of potentially affected firms surrounding the draft directives' release, my co-authors and I find a significant abnormal capital market reaction of -0.692 percent. This capital market reaction corresponds to an absolute market value reduction of more than 52 billion euros, 40 percent of which is attributable to U.S. firms. Investor reaction is more pronounced for firms that engage more in tax avoidance and those with higher EU exposure. Overall, we conclude that investors perceive the event as a threat to firms' future profitability and that they react in line with the proposals' intentions to secure tax revenues and extract location-specific rent.

Section 6 finally closes with a summary of the key findings of this dissertation.

2. Quantifying the OECD BEPS Indicators – An Update to BEPS Action 11[1]

2.1. Introduction

"The use of any indicators to identify the scale and economic impact of BEPS can only provide 'general indications' and the interpretation of any such indicators must be heavily qualified by numerous caveats."

(OECD, 2015b, p. 41)

Profit shifting of multinational corporations is a pressing topic in the public debate, academic research and on the political agenda. The debate on legal tax avoidance is fueled by anecdotal evidence on extremely low effective tax rates (ETRs) by multinational enterprises (MNEs). Especially, United States (U.S.) companies with valuable intellectual property (IP), such as Google, Apple, and Amazon, are in the public focus for being tax 'aggressive'.[2]

The issue of 'aggressive' tax planning and cross-border income relocation is, of course, not new to policymakers. The release of the well-known Action Plan on Base Erosion and Profit Shifting (BEPS) by the Organization for Economic Cooperation and Development (OECD) in 2013 has lifted the issue to one of the top priorities in international politics. Since then, many nations have implemented far-reaching reforms to prevent 'aggressive' income shifting, to strengthen anti-tax avoidance legislation and to conserve corporate tax revenues. While some reforms are part of coordinated supranational actions, e.g., the EU Anti-Tax Avoidance Directive, others are purely unilateral legislations to protect national tax revenues, e.g., the

[1] This section is joint work with Daniel Klein, Katharina Nicolay and Christoph Spengel. It is published as ZEW Discussion Paper 21-013. We thank Nadine Riedel (discussant), Johannes Voget (discussant), the participants of the joint Tax Foundation and European Tax Policy Forum (ETPF) 2020 conference and the participants of the Mannheim Taxation Campus Meeting 2020 for valuable comments. This paper was prepared for the joint Tax Foundation and ETPF conference on "The State of Uncertainty: Reflections on BEPS and the OECD's Two-Pillar Approach" in November 2020. We gratefully acknowledge financial support from the Graduate School of Economic and Social Sciences of the University of Mannheim and from the ETPF.

[2] The effective tax rate of big tech companies is regularly discussed in the public media and Margarethe Vestager, European Commissioner for Competition, has become publicly known for her focus on illegal state aid cases and tax affair investigations. See, for example, https://www.ft.com/content/79b56392-dde5-11e8-8f50-cbae5495d92b; https://www.theguardian.com/technology/2018/oct/08/facebook-uk-tax-bill-sales-margaret-hodge and https://www.bloomberg.com/news/articles/2019-09-16/apple-takes-on-eu-s-vestager-in-record-14-billion-tax-battle.

French Digital Services Tax. Prominently, the OECD has recently proposed a far-reaching two-pillar reform to adjust the worldwide corporate tax system.[3]

Despite the proposed actions to prevent BEPS and the heightened public awareness against 'aggressive' tax planning, it is still a major challenge to credibly measure the extent of profit shifting and to assess its economic relevance (Blouin and Robinson, 2020; Bradbury et al., 2018; Tørsløv et al., 2020). In the 2015 published Final Report on "Measuring and Monitoring BEPS, Action 11", the OECD introduced six indicators to measure and evaluate BEPS activity over time and on different levels of aggregation (OECD, 2015b). The six OECD BEPS indicators intend to identify the scale and economic impact of BEPS, track changes in BEPS over time and monitor the effectiveness of measures implemented to reduce BEPS (OECD, 2015b). In conjunction with the introduction, the OECD provides numbers for each indicator for the period from 2005 to 2012. These values are interpreted to provide strong signals on the existence and exacerbation of BEPS (Bradbury and O'Reilly, 2018). However, ever since these indicators have not been revised or quantitatively updated by the OECD.

In this paper, we transparently replicate a selection of the six OECD indicators to measure and monitor BEPS. We provide an update to the numbers underlying the ongoing political debate to reform the global corporate income tax system. Our work builds on the theoretical evaluation of the indicators by Heckemeyer et al. (2021). The authors argue that the main objective of the OECD BEPS indicators, to provide understandable and easy to replicate measures of BEPS, comes at the price of too simplistic measures that prevent a reliable tracing of profit shifting. It is beyond the scope of this paper to conceptually re-assess whether the indicators are well suited to capture profit shifting. Our aim is to provide a numerical update and to point out potential pitfalls when interpreting the indicator values; because we agree that

[3] Pillar One proposes a "Unified Approach" that is designed to allocate taxing rights to market jurisdictions (Beer et al., 2020; OECD, 2020a). Pillar Two, the "Global Anti-Base Erosion" (GloBE) proposal, intends to counteract all remaining profit shifting risks by introducing a coordinated global minimum tax and a deduction disallowance that should, in general, apply to all transactions (Devereux et al., 2020; OECD, 2020b).

a broad range of estimates on the existence and extent of profit shifting is necessary to provide policymakers with a solid foundation for any decision making and evaluation of policy actions.

We categorize the six OECD BEPS indicators in three different groups based on their underlying data and measurement rationale. The first indicator group uses macro data to highlight a potential disconnect between financial and real economic activities. This category comprises Indicator 1: Concentration of foreign direct investment relative to the Gross Domestic Product (GDP). The second group uses micro data to identify surprisingly low profit or tax measures. This category comprises Indicator 2: Differential profit rates compared to effective tax rates; Indicator 3: Differential profit rates between low-tax locations and worldwide MNE operations; and Indicator 4: Effective tax rates (ETRs) of large MNE affiliates relative to non-MNE entities with similar characteristics. The third indicator group uses micro and macro data to measure the use of potential profit shifting channels. This category comprises Indicator 5: Concentration of high levels of royalty receipts relative to research and development (R&D) spending; and Indicator 6: Interest expense to income ratios of MNE affiliates in high-tax locations. We revive one indicator from each category to shed light on its development over time. Our choice relies on the assessment in Heckemeyer et al. (2021) and we are confident to focus on the most convincing indicator in each category, namely Indicator 1, Indicator 4, and Indicator 5.

Indicator 1 relies on macro-level data and intends to indirectly measure BEPS that takes place through the use of offshore tax havens. By replicating this indicator, we transparently show that countries that are often expected to serve as conduits or final destinations for BEPS have a disproportionately high amount of gross or net foreign direct investment (FDI) in relation to economic activity measured by GDP. Extrapolating the indicator values to recent years reveals a downward (stable) trend for the relation of average net (gross) FDI to GDP ratios between countries with very high and lower concentrations of FDI relative to their economic activity. However, since the indicator is unable to distinguish between real economic activity

and BEPS, the estimates and their variation over time may be driven by factors unrelated to BEPS, such as trade openness or business cycles.

Indicator 4 employs firm-level micro data to evaluate cross-border profit shifting of multinational corporations and addresses the well-known drawbacks of highly aggregated macro data. Due to the usage of advanced statistical methods and counterfactuals, Indicator 4 has been identified in previous work to represent the most promising approach (Heckemeyer et al., 2021). Replicating the OECD's regression, we show that the ETR differential between MNE and non-MNE affiliates is negative and statistically significant for almost all years in our sample. Yet, the difference diminishes over time. In line with Bilicka (2019), we extend the OECD's fourth indicator by applying a propensity score matching approach. The qualitative insight holds. MNEs tend to have lower effective tax rates than comparable domestic firms. Despite the promising approach to compare MNEs with similar domestic firms, the ETR is by construction not suitable to capture profit shifting. If at all, the recommended measure indicates certain forms of special tax incentives, loss-offsets, hybrid mismatch arrangements, tax negotiations or other non-profit shifting related methods to reduce a firm's tax burden.

Indicator 5 relies again on macro-data rather than firm-level data and is concerned with profit shifting through intangibles. We show that countries with high ratios of royalty receipts to research and development spending, which builds the rationale of Indicator 5, are countries with low corporate income tax rates or special tax regimes, e.g., Ireland, the Netherlands and Luxembourg. Moreover, the indicator remains constant over time and does not seem to react to recent policy actions to curb BEPS. However, the simplistic design of Indicator 5, which lacks any link to countries' tax rates, is to some extent arbitrary and completely neglects potential real economic activities of MNEs.

Our analysis shows that despite the OECD's intention to provide a dashboard of indicators to evaluate the existence and scale of BEPS and to measure and monitor how BEPS evolves over time, the indicators presented in the Final Report on BEPS Action 11 are unlikely

to achieve this goal convincingly. Their simplistic design comes at the price of making them vulnerable to a number of confounding factors and economic effects that go beyond profit shifting. The OECD (2015b) acknowledges several shortcomings of their indicators itself and our selected replication of three indicators confirms these issues. Overall, the indicators provide only limited information on the extent of profit shifting and lack the ability to precisely identify any changes to BEPS that result from recent tax reforms and enactments of BEPS countermeasures.

With this transparent replication and update of simple indicator values that are taken as a rationale for global tax reforms, we contribute to the public and political debate on profit shifting of MNEs. However, we recommend to base policy decision on the numerous empirical studies that in general exploit well-specified identification strategies and granular data to show the existence of BEPS and to develop convincing estimates of the level of income shifting and the effects of BEPS countermeasures (see e.g., Hanlon and Heitzman, 2010; Heckemeyer and Overesch, 2017; Riedel, 2018; Wilde and Wilson, 2018). The academic debate on the extent of BEPS and its fiscal effects has recently gained momentum (Blouin and Robinson, 2020; Bradbury et al., 2018; Tørsløv et al., 2020). Blouin and Robinson (2020) critically discuss the broad range of profit shifting estimates and assess different data sources. Especially, the careful evaluation of new data such as public country by country reporting can shed light on the extent of profit shifting (Clausing, 2020; Dutt, Nicolay, et al., 2019). Moreover, analyzing different profit shifting channels separately allows to apply targeted measures and data sources and provides a promising approach to evaluate the effectiveness of specific BEPS countermeasures (see e.g., Beer and Loeprick, 2015; Clausing, 2003; Dischinger and Riedel, 2011; Lohse and Riedel, 2013; Overesch, 2016; Saunders-Scott, 2015).

This section is organized as follows: Section 2.2 covers the replication of Indicator 1, the concentration of foreign direct investment relative to GDP. The subsequent sub-section covers the replication of Indicator 4, the comparison of effective tax rates of large MNE affiliates with

non-MNE entities. Section 2.4 covers the replication of Indicator 5, profit shifting through intangibles. Each section has three major subsections. First, we describe the methodology and data necessary to estimate each indicator. Second, we show the results and third, we critically assess the rationale and shortcomings of the indicators. Finally, section 2.5 concludes.

2.2. Concentration of Foreign Direct Investment Relative to GDP

"This macro-economic indicator is the ratio of the stock of FDI to a country's GDP, measure of real economic activity. The indicator compares the FDI ratio in countries with relatively high values of FDI to GDP ratios to the same ratio in the rest of the included countries."

(OECD, 2015b, p. 49)

2.2.1. Methodology and Data

OECD Indicator 1 relies on macro-level data and intends to indirectly measure BEPS that takes place through the use of offshore tax havens, which is the strategy of MNEs to channel funds to affiliates in low-tax countries for tax purposes. In order to measure the movement of funds, the OECD focuses on FDI. FDI measures the amount of cross-border investments of related affiliates and includes not only investments related to BEPS but also to real economic activity. As FDI patterns can generally be expected to be proportional to the economic size of the involved countries (Head and Ries, 2008), significantly high concentrations of FDI to GDP may signal BEPS. Following these considerations, Indicator 1 is based on the ratio of FDI stock in a country owned by foreign investors to the GDP of that country in a given year. Based on the magnitude of this ratio in a pre-determined base year, countries are assigned to two different groups – high-ratio countries and low-ratio countries – and remain in this group in all years. For each group, the average of the ratio of FDI stock to GDP is determined and the indicator expands as follows:

$$Indicator\ 1_t = \frac{\frac{\sum_{i=1}^{I} FDI_{i,t}}{\sum_{i=1}^{I} GDP_{i,t}}}{\frac{\sum_{j=1}^{J} FDI_{j,t}}{\sum_{j=1}^{J} GDP_{j,t}}} \quad (1)$$

where subscript i refers to countries in the high-ratio group and subscript j to countries in the low-ratio group.

The OECD distinguishes between two different measures of FDI. The net FDI of a country is calculated as the inward FDI stock in that country owned by foreign investors from OECD countries less the outward FDI stock from domestic investors that is held in OECD countries. Hence, this measure is supposed to identify those countries that are the ultimate destination of foreign direct investments for the purpose of BEPS. The OECD determines a threshold of 50 percent of the net FDI to GDP ratio for assigning countries into the two groups.

The second measure of FDI relies on the gross inward FDI stock in a country owned by foreign investors from OECD countries. In addition to countries that are the ultimate destinations for FDI, this measure is intended to also capture conduit countries with a high proportion of FDI stock relative to GDP. The OECD defines a threshold of 200 percent of gross FDI to GDP for assigning countries into the two groups.

We replicate both measures using 2012 and 2018 as the base years for group allocation. We also conduct the analyses by recalculating the two groups continuously on a yearly basis. For our calculations, we employ two different sets of data from the OECD Foreign Direct Investment Statistics. We firstly use FDI position data of the 3rd edition of the Benchmark Definition of FDI (BMD3). The data includes inward and outward FDI positions from and to OECD countries for the time period from 2005 to 2013. Secondly, we use FDI position data of the 4th edition of the Benchmark Definition of FDI (BMD4) for the time periods from 2014 to

Table 2: Indicator 1 – country-year distribution

Panel A: Net FDI

Year	Number of Countries
2005	189
2006	190
2007	190
2008	193
2009	192
2010	195
2011	195
2012	196
2013	198
2014	196
2015	196
2016	195
2017	193
2018	187

Panel B: Gross FDI

Year	Number of Countries
2005	197
2006	200
2007	202
2008	201
2009	200
2010	200
2011	202
2012	202
2013	203
2014	199
2015	199
2016	197
2017	196
2018	191

Notes: The table shows the number of countries with available data per year. Panel A refers to the net FDI to GDP measure. Panel B refers to the gross FDI to GDP measure of Indicator 5. The years 2005 until 2012 rely on the BMD3 definition of Foreign Direct Investment while the years 2013 until 2018 rely on BMD4.

2018.[4] Additionally, we obtain GDP data in current U.S. dollar for the years 2005 until 2018 from the World Bank.[5] The dispersion of countries with available data is shown in Table 2.

Moreover, the BMD4 data allow us to observe FDI inflows and outflows of special purpose entities (SPEs). As defined by the OECD, SPEs are established in economies other than those in which the parent firm is resident and engage primarily in international transactions

[4] Since September 2014, the OECD has been collecting FDI statistics from member countries according to the updated benchmark definition BMD4. The methodology of the FDI statistics published between 1990 and end-2013 relates to the 3rd edition of the benchmark definition.

[5] World Bank indicator code: NY.GDP.MKTP.CD

but in few or no local operations. Therefore, FDI in SPEs might be considered especially BEPS-motivated.

2.2.2. Results

First, we replicate the OECD's estimation of Indicator 1, taking net FDI to GDP as the measure and 2012 as the base year. For 2012, we have data on 202 countries, of which 14 are assigned to the high-ratio group. Unsurprisingly, members of the high-ratio group are countries with low or no corporate income tax (CIT) rate or preferential tax systems, e.g., the Bahamas, Cayman Islands or Ireland. The structure of the high-ratio group is depicted in Table 3 Panel A.

Table 3: Indicator 1 – countries in high-ratio group

Panel A: Net FDI

	Base Year 2012	Base Year 2018
1	Bahamas	Barbados
2	Barbados	Cyprus
3	Bermuda	Dominica
4	Cayman Islands	Ireland
5	Hong Kong	Marshall Islands
6	Hungary	Mauritius
7	Ireland	Mongolia
8	Liberia	Netherlands
9	Malta	Panama
10	Marshall Islands	Papua New Guinea
11	Mauritius	St. Kitts and Nevis
12	Singapore	Singapore
13	St. Kitts and Nevis	Turks and Caicos Islands
14	Trinidad and Tobago	

Panel B: Gross FDI

	Base Year 2012	Base Year 2018
1	Bahamas	Bahamas
2	Barbados	Barbados
3	Bermuda	Curacao
4	Cayman Islands	Cyprus
5	Curacao	Ireland
6	Ireland	Luxembourg
7	Luxembourg	Malta
8	Malta	Marshall Islands
9	Marshall Islands	Mauritius
10	Netherlands	Netherlands
11		Switzerland

Notes: The table shows the countries belonging to the high-ratio group. Countries with a ratio above 50 percent are assigned to the group of high-ratio countries while the other countries form the group of low-ratio countries. In Panel A the group structure is shown for the net FDI to GDP measure using base years 2012 and 2018, respectively. In Panel B the group structure is shown for the gross FDI to GDP measure using base years 2012 and 2018, respectively.

Using the BMD3 data from 2005 to 2012, we can closely replicate the results of the OECD, which are shown in Table 4 Panel A and graphically plotted in Figure 1. In 2011, the indicator shows that the average ratio of net FDI to GDP of the high-ratio countries was about 43 times higher than the average ratio of low-ratio countries. The indicator values are depicted in Figure

Table 4: Indicator 1 – results

Panel A: Net FDI

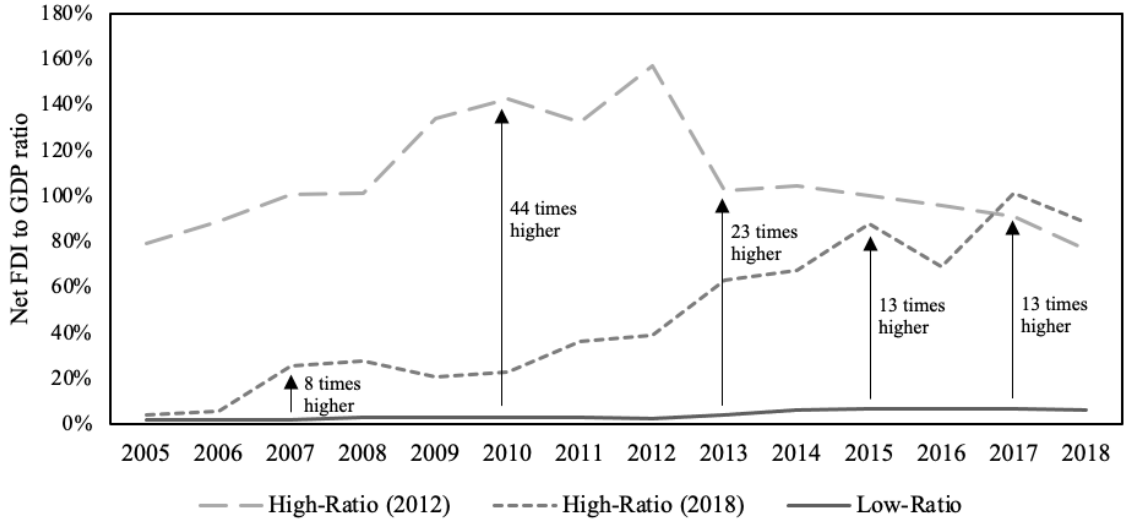
Year	OECD	Base Year 2012			Base Year 2018		
	Indicator	High	Low	Indicator	High	Low	Indicator
2005	37,6	79%	2%	37,5	4%	3%	1,3
2006	36,3	89%	2%	43,1	6%	3%	1,8
2007	37,4	101%	2%	44,6	26%	3%	8,0
2008	31,9	102%	3%	31,3	28%	4%	6,8
2009	41,9	134%	3%	42,3	21%	5%	4,5
2010	44,9	143%	3%	44,3	23%	5%	4,8
2011	43,1	132%	3%	41,4	36%	4%	8,5
2012	99,2	157%	3%	54,8	39%	4%	9,2
2013		102%	4%	23,9	63%	4%	14,3
2014		105%	6%	16,3	68%	7%	10,4
2015		100%	7%	14,6	88%	7%	13,3
2016		96%	7%	13,9	69%	7%	9,9
2017		91%	7%	12,9	102%	6%	15,8
2018		77%	7%	11,7	88%	6%	14,9

Panel B: Gross FDI

Year	OECD	Base Year 2012			Base Year 2018		
	Indicator	High	Low	Indicator	High	Low	Indicator
2005	13,0	175%	14%	12,4	125%	14%	8,9
2006	13,9	202%	15%	13,1	145%	15%	9,4
2007	15,9	247%	16%	15,0	167%	17%	9,9
2008	17,4	262%	16%	16,5	176%	16%	10,9
2009	18,9	323%	18%	17,7	207%	19%	11,0
2010	21,1	349%	18%	19,9	215%	18%	11,9
2011	23,4	359%	16%	22,1	215%	17%	12,8
2012	26,7	406%	17%	24,4	240%	17%	14,0
2013		504%	21%	23,5	332%	21%	15,6
2014		518%	23%	22,5	363%	22%	16,3
2015		602%	25%	24,0	417%	24%	17,2
2016		612%	26%	23,5	434%	25%	17,4
2017		660%	27%	24,4	482%	26%	18,7
2018		524%	25%	20,8	422%	23%	18,0

Notes: The table depicts the values of Indicator 1. In Panel A net FDI is used to estimate the indicator. In Panel gross FDI is used. Column 2 shows Indicator values estimated by the OECD (OECD, 2015b). For each countr the ratio of FDI to GDP is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high ratio groups or low-ratio groups. The threshold values amounts to 50% in Panel A and 200% in Panel B. In columr 3 to 5 2012 is the base year and column 3 and 4 show the ratio of the countries in the high-ratio group and low-rati group, respectively. Column 5 displays the estimated indicator value. In columns 6 to 8, 2018 is the base year an column 6 and 7 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column displays the estimated indicator value. The years 2005 until 2012 rely on the BMD3 definition of Foreign Direc Investment as data source while the years 2013 until 2018 rely on BMD4.

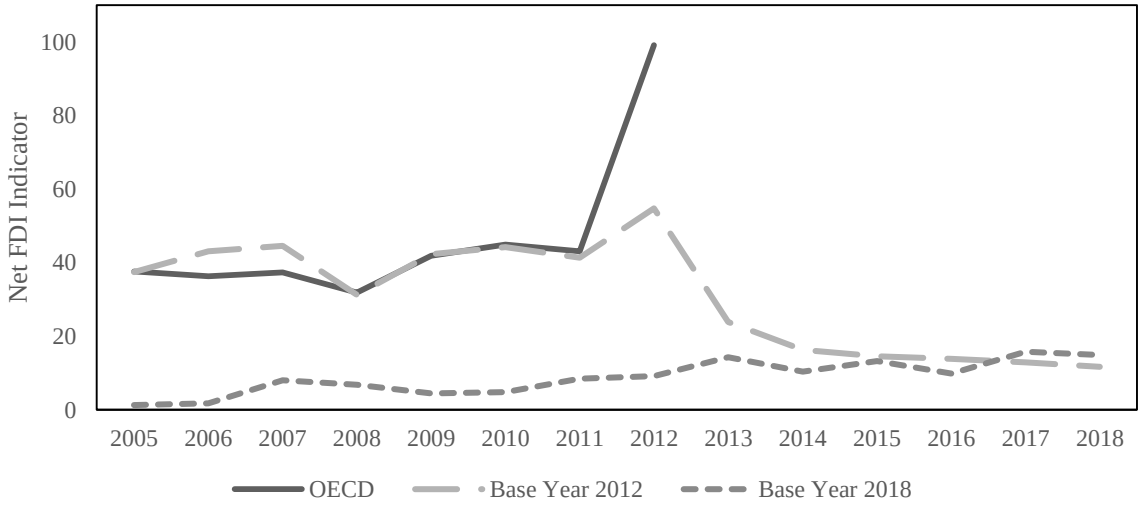
Figure 1: Indicator 1 – net FDI to GDP by groups



Notes: The dashed line depicts the trend of the average net FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2012. The dotted line depicts the trend of the average net FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2018. The solid line displays the average ratio of the remaining (low-ratio) countries.

2. However, we do not find the OECD's sharp increase in the indicator value in the year 2012, in which our estimate increases to 54.8 in contrast to 99.2 estimated by the OECD. Employing the BMD4 data from 2013 onwards, we see a drop in the indicator value to 23.9, which then steadily decreases to 11.7 in 2018.

Figure 2: Indicator 1 – net FDI indicator trend

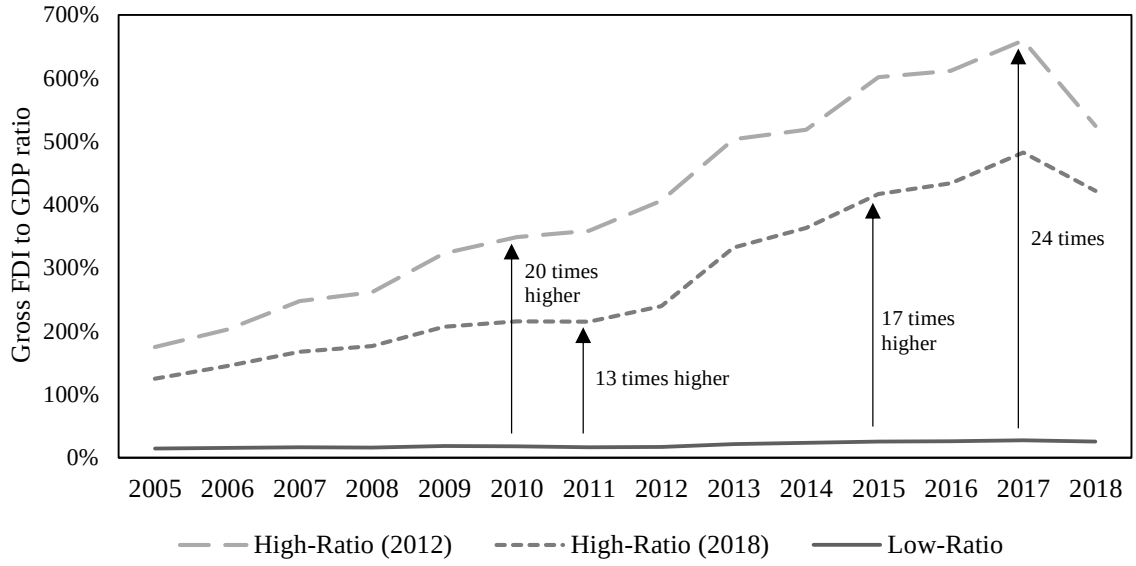


Notes: The dashed line shows the trend of Indicator 1 using net FDI to GDP as measure and 2012 as base year. The dotted line uses 2018 as base year for group allocation. The solid black line shows the indicator's trend estimated by the OECD in 2015.

When taking 2018 as the base year for group allocation, we identify 13 countries in the high-ratio group, which is depicted in the right column of Table 3 Panel A. In 2005 and 2006, the average ratio of net FDI to GDP of the high-ratio group was only marginally higher. After this time, we find a steady increase to an indicator value of around 14, which remains stable until 2018.

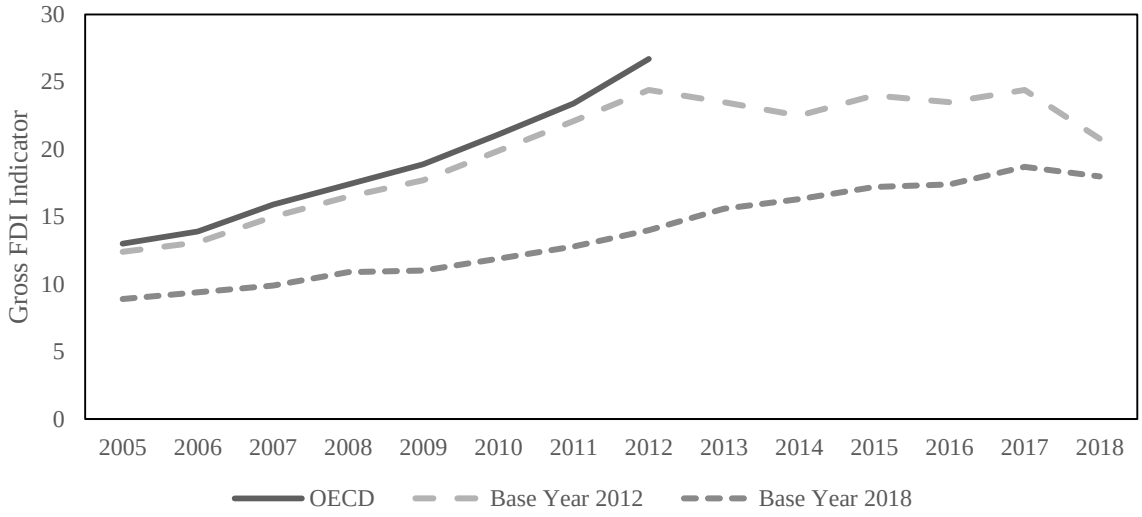
Second, we replicate the OECD's indicator using the gross FDI to GDP ratio. The OECD claims that by using gross FDI values, the indicator also captures those countries that function as conduits for BEPS. When using 2012 as the base year, ten out of 202 countries are assigned to the high-ratio group and, indeed, countries such as Ireland, the Netherlands and Luxembourg are part of the high-ratio group which are considered as members of the top ten conduit countries (van 't Riet and Lejour, 2018). Table 3 Panel B displays the list of all countries in the high-ratio group. From 2005 to 2012, we are able to closely replicate the OECD's estimates. Table 4 Panel B depicts the indicator values. In 2005, the gross FDI to GDP ratio of the high-ratio countries is about 12 times higher than the ratio of the low-ratio countries and doubles to 24 until 2012. In the following years, the indicator value remains at a level of about 23. Figure

Figure 3: Indicator 1 – gross FDI to GDP by groups



Notes: The dashed line depicts the trend of the average gross FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2012. The dotted line depicts the trend of the average gross FDI to GDP ratio for the group of countries that have a ratio above 0.5 in 2018. The solid line displays the average ratio of the remaining (low-ratio) countries.

Figure 4: Indicator 1 – gross FDI indicator trend



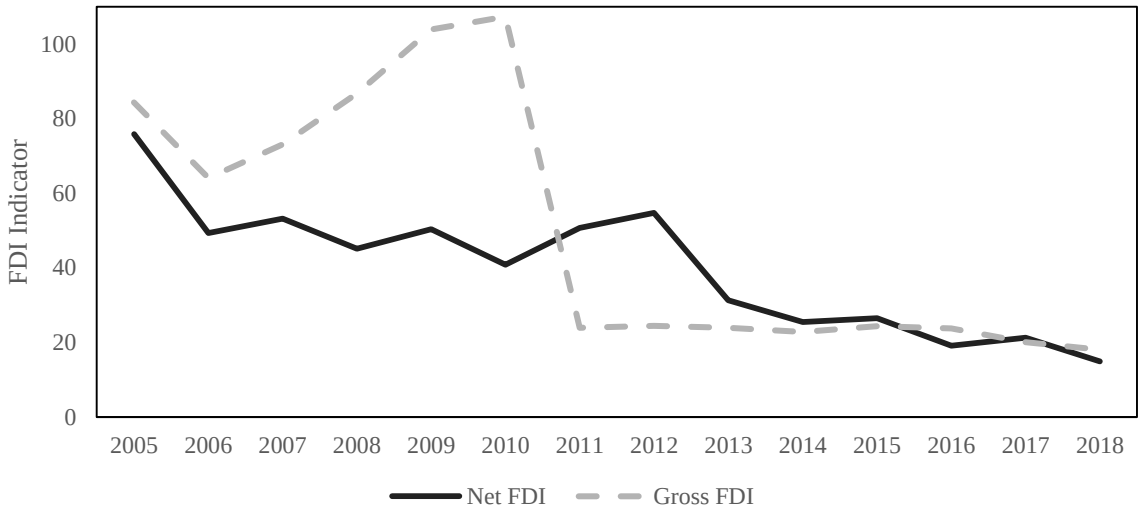
Notes: The dashed line shows the trend of Indicator 1 using gross FDI to GDP as measure and 2012 as base year. The dotted line uses 2018 as base year for group allocation. The solid black line shows the indicator's trend estimated by the OECD in 2015.

3 shows that in 2018, the amount of gross FDI per euro of GDP in the high-ratio group of countries was, on average, 19 times higher than the average ratio for the remaining countries. When taking 2018 as the base year, eleven countries belong to the high-ratio group and Figure 4 shows that the indicator trend over time is steadily increasing and doubles between 2005 and 2018.

In addition, we repeat both analyses allocating countries to into high and low-ratio groups on a continuous basis every year. For the net FDI analysis, the indicator value follows closely that of taking 2012 as base year, as depicted in Figure 5. The gross FDI indicator ranges between 60 and 100 for the years 2005 to 2010. This is about five times the value of that when taking 2012 as base year. In year 2011, the indicator value drops to 24 and remains in this magnitude for the rest of the sample period.

As robustness test, we replicate our analysis keeping only those countries for which we have data available over the whole period from 2005 to 2018 and find very similar results. Furthermore, we exploit FDI positions of SPEs in the time period from 2013 to 2018. Due to

Figure 5: Indicator 1 – net and gross FDI indicator with continuous base year



Notes: The solid black line shows the trend of Indicator 1 using net FDI to GDP as a measure, recalculating the group composition every year. The dashed line shows the trend of Indicator 1 using gross FDI to GDP as a measure, recalculating the group composition every year.

the variation in data availability, we do not find consistent results. Nevertheless, the prior identified countries in the high-ratio groups are again those countries with the highest ratios.

2.2.3. Rationale and Shortcomings

Indicator 1 relies on the assumption that a country's magnitude of (inward) FDI stock to GDP provides an indication of BEPS. Specifically, MNEs are supposed to channel funds to low-tax countries for tax reasons and not for reasons of real economic activity. Indeed, prior literature provides evidence on the adverse relationship of taxes and FDI (Buettner et al., 2018; Desai et al., 2004; Janeba, 1995). BEPS related FDI is expected to create a disproportion between the FDI in a country and the economic activity of this country, measured by GDP. The indicator intends to capture this disproportion. However, the definition of the indicator has many drawbacks. First, FDI includes both investments related to BEPS and investments related to real economic activity. Since the indicator is unable to distinguish between these types of investment, the estimates and their variation over time may be driven by factors unrelated to BEPS, such as trade openness or business cycles. Second, the indicator does not provide any direct linkage to countries' tax rates which is the key driver for BEPS related FDI. Third, the indicator values highly depend on the specific threshold and base year to assign countries to the two different groups. This is highlighted by the high indicator value dispersion when using

continuous base years. Overall, we explicitly point out that the results have to be treated with caution and conclude that Indicator 1 does not provide convincing (indirect) evidence of BEPS.

2.3. Effective Tax Rates of Large MNE Affiliates Compared to Non-MNE Entities

"Indicator 4 compares the ETRs of large MNE affiliates with non-MNE entities with similar characteristics in the same country. The indicator measures the extent to which large MNE affiliates have lower ETRs than comparable non-MNE entities."

(OECD, 2015b, p. 58).

2.3.1. Methodology and Data

This OECD indicator relies on firm-level micro data to evaluate cross-border profit shifting of MNEs and addresses the well-known drawbacks of highly aggregated macro data that is used to estimate the first OECD Indicator. In contrast to purely domestic firms, which operate only in one country, MNEs have incentives to relocate income to affiliates located in countries with lower corporate tax rates. The fourth OECD indicator exploits this difference between domestic and multinational corporations. Domestic firms serve as a counterfactual benchmark group to assess the extent of income shifting by comparable multinationals. The indicator uses financial data of multinational and domestic firms and compares the average ETR of both groups. The OECD expects that the ETR of MNEs is, on average, lower than that of comparable domestic firms (OECD, 2015b).

The presumption of lower ETRs for MNEs is tested using the following regression framework:[6]

$$ETR_{f,c,i,t} = \beta_1 large_{f,c,i,t} x\ year_t + \beta_2 large_{f,c,i,t}\ x\ MNE_{f,c,i}\ x\ year_t + \beta_3 X_{f,c,i,t} + \delta_i + \delta_{c,t} \quad (2)$$

[6] Note that the regression framework deviates slightly from the regression stated in Annex 3. A1 in OECD (2015b). We only exclude the dummy variable small, which is the exact counterpart to the variable large. We further directly interact the coefficient of interest (and its baseline effect) with a year dummy to obtain yearly estimates, as presented in Table 2.3. Indicator 4 in OECD (2015b).

where $ETR_{f,c,i,t}$ is the effective tax rate for firm f in country c, industry i and year t. The ETR is the ratio of tax payments to earnings before income and taxes (EBIT) in percent. $Large_{f,c,i,t}$ is a dummy variable that takes the value of 1 for firms with more than 250 employees and 0 otherwise. Multinational firms are identified using the dummy variable $MNE_{f,c,i}$. The group structure is based on the ORBIS ownership information at the end of year 2016 and we restrict the sample to majority owned firms and headquarters. The group structure is assumed to be constant in our panel.[7] We require a multinational group to have at least one cross-border relationship. β_2, the estimated coefficient of the interaction between large and multinational firms, is the coefficient of interest and the estimated value of Indicator 4. We exclude the baseline effect of multinationals on the ETR to obtain a direct estimate of the OECD's verbally expressed difference between the ETR of large multinational and large domestic corporations. $Year_t$ is a dummy variable that is interacted with the coefficient of interest to provide yearly estimates. $X_{f,c,i,t}$ is a vector of firm-specific control variables. It includes the size of a firm, measured as the logarithm of total assets, the profitability ratio of a firm and an estimate for the degree of firms' innovation activities. We use the ratio of intangible to total assets as a proxy for firms' innovativeness in contrast to the number of patents that is used by the OECD. Furthermore, a dummy variable that indicates if a firm is the global ultimate owner controls for a firm's position in the group. δ_i are industry fixed effects at the two-digit NACE classification and $\delta_{c,t}$ are country-year fixed effects.

In line with the OECD, we use unconsolidated financial data from the well-known Bureau van Dijk ORBIS database to replicate the estimates of Indicator 4. Our panel starts in 2000 and has data up to 2016. Similar to other studies on profit shifting, we exclude observations with implausible financial data such as total assets below zero and exclude all observations that have a negative effective tax rate or one above 100 percent (Beer and Loeprick, 2015; Dischinger

[7] This assumption is commonly used in the literature on profit shifting. Many changes in the ownership structure result from data improvements by the data provider.

and Riedel, 2011; Huizinga and Laeven, 2008). Furthermore, we restrict the sample to firms with a profitability ratio, which is determined as EBIT to total assets, between zero and 100 percent, i.e., we exclude loss-making firms and overly profitable corporations. Finally, we exclude all firms with less than three years of basic accounting data available in our panel (Beer and Loeprick, 2015).

2.3.2. Results

Our panel from 2000 to 2016 consists of more than 800,000 firms, thereof about 18 percent are multinational firms. Descriptive statistics are depicted in Table 5. In our baseline regression, depicted in Table 6, we estimate large MNEs to have a 0.96 percentage points lower ETR than comparable large domestic firms, which is significant at the one percent level. This estimate decreases to about -1.5 if we only consider the period from 2000 until 2010 that corresponds to the OECD sample period. Yet, the OECD estimates that the ETR of large MNEs is, on average, three percentage points below the ETR of comparable large domestic corporations (OECD, 2015b). We replicate the yearly estimates of the ETR differential in Appendix 1. The interaction coefficient of large and multinational corporations is directly comparable to the estimates of Indicator 4 in the final report on BEPS Action 11. Our estimates on the differential between

Table 5: Indicator 4 – descriptive statistics

Variable	n	Mean	SD	Min	Median	Max
ETR	5,048,716	31.248	20.075	0.000	28.073	100.000
Employees	5,048,716	136	2,477	1	15	1,477,200
Large dummy	5,048,716	0.075	0.263	0.000	0.000	1.000
MNE dummy	5,048,716	0.220	0.414	0.000	0.000	1.000
Profitability	5,048,716	0.116	0.122	0.000	0.077	1.000
Total Assets (TOAS)	5,048,716	123,32.850	31,017.534	0.249	1,579.236	158,697.237
Innovation	5,048,716	0.054	0.117	0.000	0.007	0.785
Position in group	5,048,716	0.684	0.465	0.000	1.000	1.000

Notes: The table depicts the descriptive statistics. ETR is the ratio of tax payments to profit and loss before tax. Employees is the number of staff per firm. Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. ETR, Profitability, Innovation are measured in percent. Employees in total numbers and total assets in thousand Euro.

Table 6: Indicator 4 – baseline regression

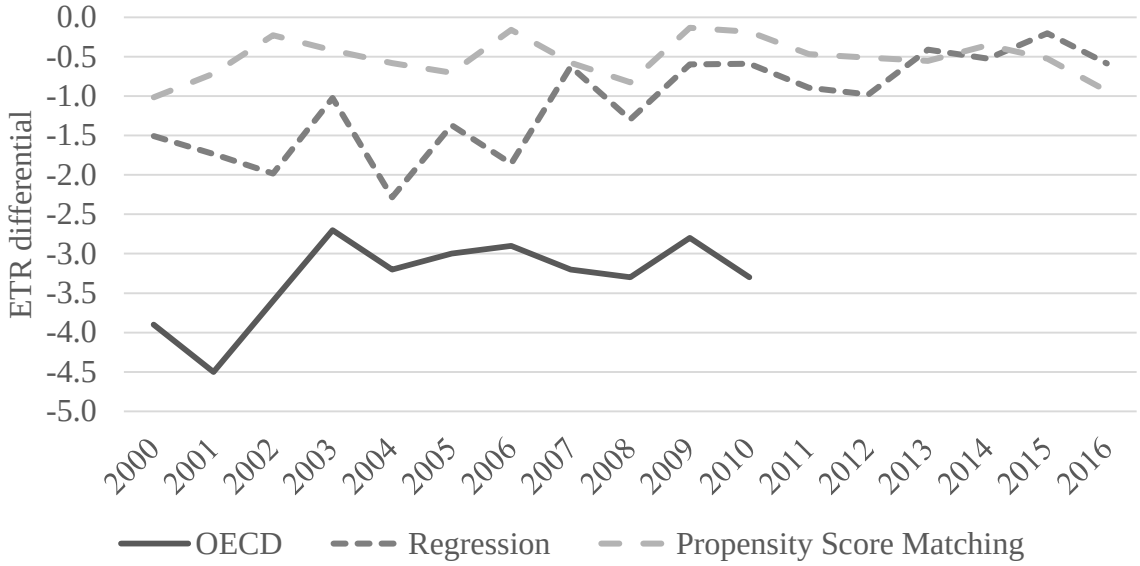
Variable	(1)	(2)
Large	0.5886***	0.7142***
	(0.0855)	(0.1059)
Large x MNE	-0.9606***	-1.4648***
	(0.0982)	(0.1221)
Profitability (EBIT/TOAS)	-23.4167***	-19.0960***
	(0.0940)	(0.1095)
log Total Assets (TOAS)	-0.2308***	-0.1130***
	(0.0088)	(0.0105)
Innovation (IFAS/TOAS)	-2.3959***	-3.5671***
	(0.1010)	(0.1148)
Position in Group	-0.7428***	-0.8877***
	(0.0300)	(0.0352)
Country-Year Fixed Effects	x	x
Industry Fixed Effects	x	x
Time limited to 2010		x
R2 (within)	0.362	0.363
Number of firms	1,001,429	751,148
Observations	5,048,716	2,796,459

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the effective tax rate (ETR). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

large MNE affiliates and non-MNE entities are considerably below the annual estimates of the OECD. We plot the yearly coefficients in Figure 6. Yet, we also see a negative and statistically significant ETR differential for almost all years. The ETR differential follows for the second half of our sample period – that extends beyond the OECD's period – an upward trend and converges towards zero.

We conduct several robustness tests. First, we restrict the sample to specific regions. In column 3 of Appendix 1 we only consider firms located in an OECD country, and in column 4, we only consider firms located in EU countries. The results do not change materially. Second, we change the outcome variable to tax payments over total assets to account for the critique on the chosen outcome variable in the OECD regression approach (Heckemeyer et al., 2021). The regression is depicted in Appendix 2. The relative tax payments to total assets are, on average, only significantly lower for large MNEs than for large domestic firms in the early sample period.

Figure 6: Indicator 4 – trends in international tax planning, 2000-2016



Notes: The grey dotted line depicts the annual regression estimates for Indicator 4. The light grey dashed line depicts the annual regression estimates for the ATE, based on the two-step propensity score matching method. The solid black line shows the indicator's trend estimated by the OECD.

2.3.3. Additional Analysis – Propensity Score Matching

The OECD's regression approach to compare domestic and multinational corporations is an intuitive empirical methodology and the differences to alternative, more sophisticated, matching estimates are presumably of minor empirical importance (Angrist and Pischke, 2008). Yet, the quality of the comparison between multinational and domestic firms crucially hinges on the matching quality, i.e., the similarity and comparability of the two groups is essential for any inferences. A well-established method of creating a control group that is as similar as possible to the treaded group in a non-experimental setting is the so-called propensity score matching (Abadie and Imbens, 2006, 2016; Rosenbaum and Rubin, 1983; Rubin, 1974). Bilicka (2019) applies propensity score matching for a sample of UK MNEs and domestic firms to evaluate BEPS. The matching process follows a two-step procedure. First, the likelihood of firms being domestic or multinational is estimated based on observable characteristics. Second, domestic and multinational firms are matched based on the estimated propensity scores. The method excludes firms that are very unlikely to serve as a comparable benchmark group. The benefits of the propensity score matching approach go beyond the OECD's regression

framework. First, a key advantage is the possibility to assess the similarity of the two groups of MNE affiliates and non-MNE entities at a glance after the first matching step. Second, the propensity score matching allows to fine tune the proximity of the two groups along the observable matching dimensions. Third, a successful matching allows to directly compare the variable of interest, here the average ETR, between the two groups.

Hence, we extend the OECD's fourth indicator by applying a propensity score matching approach to estimate the average treatment effect (ATE), i.e. the differential between the average ETR of MNE affiliates and non-MNE entities or the effect of being a multinational firm, on the effective tax rates. We borrow from Bilicka (2019) and match MNEs to domestic firms. We match firms based on the logarithm of total assets, the logarithm of firm's productivity, the debt to equity ratio and the ratio of intangible to total assets within year, industry and country. All observable characteristics, which we use in the matching process, should be similar in the matched sample. Table 7 shows how the similarity of the two groups improves in the matched sample. A solid sign of matching quality is a standardized difference between the samples of close to zero and a variance ratio of about one. On average, our matched sample approaches this standard for all observable matching characteristics within each country industry and year matching cluster. We then estimate the average treatment effect for each year in our sample. Table 8 depicts the yearly estimated treatment effect of being a multinational

Table 7: Indicator 4 – propensity score matching evaluation

	Standardized Differences			Variance Ratio	
	Raw	Matched	Bias reduction	Raw	Matched
ln(TOAS)	1.2628	-0.0134	98.94%	1.3302	0.9296
ln(PROD)	0.1151	-0.0351	69.51%	1.0248	0.9369
D/E Ratio	-0.2246	0.0267	88.14%	0.4634	0.9854
Innovation	-0.0967	-0.0091	90.57%	0.8897	0.9408

Notes: This table presents the evaluation of the matching procedure on the logarithm of total assets (TOAS), the logarithm of productivity (PROD), which is the ratio of sales to total wages, the debt to equity ratio, and innovation, which is the ratio of intangible fixed assets (IFAS) to total assets (TOAS). The column Raw depicts the standardized differences and variance ratios in the unmatched sample. The column Matched depicts the standardized differences and variance ratios in the matched sample. The column Bias Reduction is the percentage reduction in the standardized differences between the unmatched and matched sample. The values depict the averages of all years. Standardized differences close to 0 and variance ratios close to 1 are indicators of a good matching quality.

Table 8: Indicator 4 – propensity score matching estimates on the ETR difference

Year	ATE
2000	-1.0154***
	(0.3164)
2001	-0.7162**
	(0.2794)
2002	-0.2295
	(0.2754)
2003	-0.4179
	(0.2605)
2004	-0.5825**
	(0.2290)
2005	-0.7053***
	(0.2086)
2006	-0.1611
	(0.1900)
2007	-0.5774***
	(0.1758)
2008	-0.8239***
	(0.1835)
2009	-0.1339
	(0.1780)
2010	-0.1824
	(0.1688)
2011	-0.4686***
	(0.1627)
2012	-0.5112***
	(0.1591)
2013	-0.5548***
	(0.1576)
2014	-0.3559**
	(0.1528)
2015	-0.5237***
	(0.1555)
2016	-0.9351***
	(0.1572)
Observations	3,669,138

Notes: The table depicts the annual average treatment effects (ATE) of being a multinational corporation on the ETR. The ATE estimates are based on a propensity score estimation procedure. The groups of multinational and domestic firms are matched on the logarithm of total assets (TOAS), the logarithm of productivity (PROD), which is the ratio of sales to total wages, the debt to equity ratio and innovation, which is the ratio of intangible fixed assets (IFAS) to total assets (TOAS). Standard errors are rely on the adjustment by Abadie and Imbens (2006) and take into account that the propensity scores to match the groups are estimated. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

firm on the ETR. We have plotted the estimated average treatment effects in Figure 6. The estimated ETR differences range between -0.13 and -1.02 percentage points and do not follow a specific trend in our sample period. In comparison to the regression estimates, the differentials are slightly smaller in the first half of our sample period. Moreover, in several years the

estimates are statistically indistinguishable from zero. The estimated ETR differentials depend – as the choice of control variables in the OECD regression approach – on the specific observable characteristics used for the propensity score matching. Hence, alternative controls or matching characteristics could lead to differences in the magnitude of the estimated ETR differentials.

2.3.4. Rationale and Shortcomings

Indicator 4 is the only indicator that includes the usage of counterfactuals as control group. This is the key advantage of Indicator 4 in contrast to all other suggested indicators to measure and monitor BEPS. However, the specifications of this indicator as defined by the OECD include other shortcomings that go beyond the matching quality that we have addressed in the preceding subsection.

It is highly questionable if the dependent variable ETR is a suitable measure to capture profit shifting. The ETR, which relates to tax expenditures over reported pre-tax profits, does not capture any of the known profit shifting channels such as transfer pricing, debt shifting nor royalty allocation (Heckemeyer et al., 2021). Specifically, the ETR's denominator is affected by profit shifting. By construction it can – if at all – indicate certain forms of special tax incentives, loss-offsets, hybrid mismatch arrangements, tax negotiations or other non-profit shifting related methods to reduce a firm's tax burden. Moreover, the unconsolidated ETR is rarely a key performance indicator of multinational corporations. Managers, and stakeholders rather focus on a group's overall tax burden, i.e. the consolidated ETR. In its current design, the indicator also neglects any differences within the group of multinational firms. While groups with affiliates in tax haven locations can be presumed to engage more actively in profit shifting, groups without links to low-tax jurisdictions might not have a strong incentive to relocate income.

2.4. Profit Shifting Through Intangibles

"The indicator compares the average ratio of royalties received to R&D expenditures for a group of high-ratio countries to the average ratio for the other countries in the sample."

(OECD, 2015b, p. 60)

2.4.1. Methodology and Data

OECD Indicator 5 relies on macro-data rather than firm-level data and is concerned with profit shifting through intangibles. Profit shifting through intangibles is commonly defined as the strategy of transferring IP from high-tax to low-tax countries for tax purposes after it has been developed in high-tax countries. Using this structure, affiliates in high-tax countries pay (potentially high amounts of) royalties for the use of the IP to affiliates in a low-tax country. The indicator shall indirectly capture the extent of BEPS through IP transfer. Following the logic of transferring IP to low-tax countries for tax purposes, IP receiving countries should have a higher ratio of royalty receipts to R&D spending compared to those countries where the IP was developed. For this reason, in a first step, the ratio of royalty receipts relative to R&D spending is measured for each country. Next, countries are assigned into two groups based on their concentration in a given year. Countries with a ratio above 50 percent are assigned to the group of high-ratio countries while the other countries form the group of low-ratio countries. By dividing the average ratio of the high-ratio group with the average ratio of the low-ratio group, Indicator 5 is formed for year t:

$$Indicator\ 5_t = \frac{\frac{\sum_{i=1}^{I} Royalty\ receipts_{i,t}}{\sum_{i=1}^{I} R\&D\ spending_{i,t}}}{\frac{\sum_{j=1}^{J} Royalty\ receipts_{j,t}}{\sum_{j=1}^{J} R\&D\ spending_{j,t}}} \tag{3}$$

where the subscript i refers to members of the high-ratio group and subscript j to members of the low-ratio group in year t.

In its 2015 report, the OECD uses the year 2011 as the base year to identify the composition of the high-ratio and low-ratio group, which is held constant in the other years.

We replicate the indicator using 2011 and 2017 as the base year.[8] We also replicate the indicator by recalculating the two groups continuously on a yearly basis. Furthermore, we check the robustness of our results through different tests.

We obtain country-level data on receipts for the use of IP as balance of payments in current U.S. dollar for the years 2005 to 2018 from the World Bank.[9] Moreover, we use data on the gross domestic expenditure on R&D from the UNESCO Institute for Statistics (UIS.Stat).[10] The data availability is depicted in Table 9.

Table 9: Indicator 5 – country-year distribution

Year	No of Countries
2005	64
2006	60
2007	72
2008	70
2009	70
2010	70
2011	69
2012	68
2013	74
2014	68
2015	74
2016	72
2017	76
2018	56

Notes: The table shows the number of countries with available data on receipts for the use of IP as balance of payments in current U.S. dollar from the World Bank and available data on the gross domestic expenditure on R&D from the UNESCO Institute for Statistics per year.

2.4.2. Results

First, we replicate the OECD's estimation of royalty receipts to R&D spending and take 2011 as the base year for allocating countries into high-ratio and low-ratio groups. In 2011, data is available for 69 countries, of which eight countries are assigned to the high-ratio group. The structure of the high-ratio group is shown in Table 10. In fact, members of the high-ratio group are European countries with low corporate income tax rates or preferential tax systems. For example, Ireland, the Netherlands and Luxembourg are part of this group.

[8] We take 2017 instead of 2018 as the base year for data availability reasons.
[9] World Bank indicator code: BX.GSR.ROYL.CD
[10] The OECD names the World Development Indicators as its data source on R&D expenditures. However, we could only find data on R&D expenditures as a percentage of GDP. Using this data would have added even larger measurement error to our calculations. We verify our results using R&D spending data from the OECD, where we obtain similar results.

Table 10: Indicator 5 – countries in the high-ratio group

	Base Year 2011	Base Year 2017
1	Guatemala	El Salvador
2	Hungary	Hungary
3	Ireland	Luxembourg
4	Lesotho	Madagascar
5	Luxembourg	Malta
6	Madagascar	Netherlands
7	Malta	Singapore
8	Netherlands	Switzerland
9		United Kingdom

Notes: The table shows the countries belonging to the high-ratio group. High-ratio countries are those countries that have a royalty receipts to R&D spending ratio of above 0.5 in a pre-defined base year. Column 1 and 2 refer to base years 2011 and 2017, respectively.

In the year 2011, the high-ratio countries received EUR 1.53 of royalty for every EUR 1 invested in R&D while the low-ratio countries received only EUR 0.18. Thus, the ratio for the high-ratio countries is almost nine times larger than that of the low-ratio countries, which leads to an indicator value of 8.7. Table 11 provides annual estimates of Indicator 5. Over the years, the indicator does not vary significantly. In 2005, the indicator takes a value of 7.7, which increases until 2010 to 9.1. After being stable for about three years, the indicator increases to 11.9 in 2015 but decreases again to 9.8 in the year 2017. Figure 7 plots the development of Indicator 5 graphically. In contrast to the estimates of the OECD, our estimated Indicator 5 value is higher but we do not observe a strong increase over time. Our estimates confirm that some countries receive comparably very high shares of royalties to R&D spending. In 2011, the eight countries in the high-ratio group received about 13.4 percent of the overall royalties of the 69 countries examined.

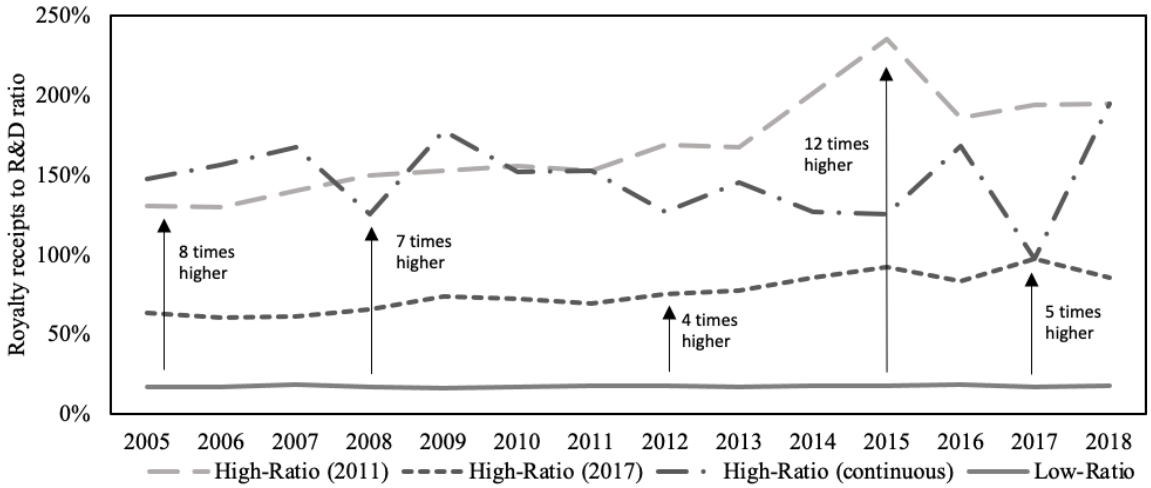
Second, we take the year 2017 as a base year for group allocation to replicate the OECD's results. The group of high-ratio countries consists of nine countries, which are named in Table 10. Table 11 and Figure 8 depict the estimates. From 2005 to 2018, the indicator ranges between 3.5 and 5.7, taking its peak in 2017. Again, the indicator values seem to be stable over time and have about the same size as the OECD's estimates. The high-ratio countries received EUR 0.98 of royalties for every EUR 1 invested in R&D in 2017, while the low-ratio countries received only EUR 0.17.

Table 11: Indicator 5 – results

Year	OECD	Base Year: 2011			Base Year: 2017			Base Year: Continuous		
	Indicator	High	Low	Indicator	High	Low	Indicator	High	Low	Indicator
2005	2,8	131%	17%	7,7	64%	16%	4,0	148%	17%	8,7
2006	2,5	130%	17%	7,6	61%	16%	3,8	157%	17%	9,2
2007	2,6	140%	18%	7,7	62%	18%	3,5	168%	18%	9,1
2008	2,5	150%	18%	8,4	66%	17%	3,9	126%	17%	7,2
2009	2,7	153%	17%	9,1	74%	16%	4,6	178%	17%	10,6
2010	4,3	156%	17%	9,1	72%	17%	4,3	152%	17%	8,9
2011	5,8	153%	18%	8,7	70%	17%	4,0	153%	18%	8,7
2012	5,8	169%	19%	9,0	75%	18%	4,3	127%	18%	7,2
2013		168%	18%	9,5	78%	17%	4,5	146%	18%	8,3
2014		201%	18%	10,9	86%	18%	4,8	127%	18%	7,1
2015		235%	20%	11,9	92%	18%	5,1	126%	18%	7,0
2016		186%	19%	9,9	84%	18%	4,6	168%	18%	9,2
2017		194%	20%	9,8	98%	17%	5,7	98%	17%	5,7
2018		195%	18%	10,7	86%	18%	4,7	195%	18%	10,7

Notes: The table depicts the values of Indicator 5. Column 2 shows indicator values estimated by the OECD (OECD, 2015b). For each country the ratio of royalty receipts to R&D spending is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high-ratio groups or low-ratio groups. The threshold values amounts to 50%. Column 3 and 4 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 5 shows the estimated indicator value. Each panel refers to a different base year for group assignment. The Worldbank and UNESCO are used as data source.

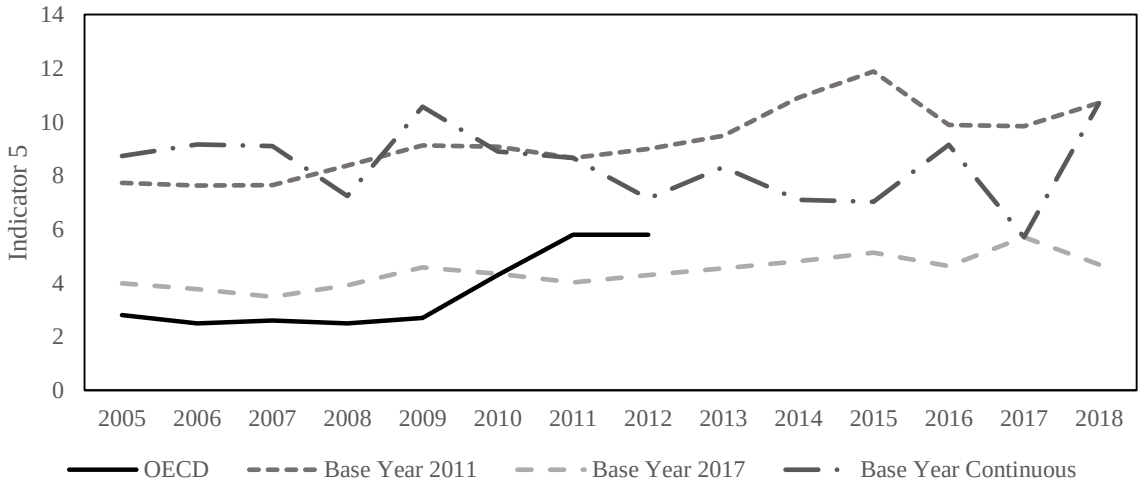
Figure 8: Indicator 5 – royalty receipts to R&D spending by groups



Notes: The dashed and dotted line depict the trend of the average royalty receipts to R&D spending ratio for the group of countries that have a ratio above 0.5 in 2011 and 2017, respectively. The dash-dotted line depicts the trend of for the group of countries that have a ratio above 0.5 in the particular year. The solid black line displays the average ratio of the remaining (low-ratio) countries.

Third, we refrain from pre-determined group allocation but re-estimate the allocation of the high-ratio and low-ratio group every year. As shown in Figure 7, the indicator values range between 5.7 and 10.7 without a clear pattern over the years. The greater dispersion can be explained by the annual re-calculation of the sample for the indicator estimation. Nevertheless, the values do not exceed or fall below those of the samples with base years.

Figure 7: Indicator 5 – indicator trend



Notes: The dashed and dotted line shows the trend of Indicator 5 using 2012 or 2017 as base year for group allocation. The dash-dotted line redefines the group allocation every year. The solid black line shows the indicator's trend estimated by the OECD in 2015.

Finally, we test the robustness of our analysis using OECD data on R&D spending. The results are depicted in Table 12. Even though the R&D data are only available for, on average, 37 countries, the results verify our previous findings. Furthermore, we replicate our analysis using only countries for which we have at least 10 years or 14 years of data available. Again, the values of the indicator do not change significantly. Lastly, we also obtain similar indicator results if we take the lag values of R&D spending for estimation. We do this to adjust for the possibility that between the time of receipts from royalty and the time of R&D spending a time gap exists.

2.4.3. Rationale and Shortcomings

Previous research has shown that MNEs transfer intellectual property to affiliates located in countries with relatively lower corporate tax rates for BEPS reasons (Amberger and Osswald, 2020; Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012). Indicator 5 is based on this rationale and aims to measure BEPS as the income stream generated by IP relative to the R&D expenditures in a country. Specifically, this assumes that MNEs use the resources of industrial countries, which often levy higher corporate tax rates, for complex R&D tasks and, subsequently, transfer the developed IP to countries with lower tax rates, causing a deviation between royalty payments and R&D expenditures.

However, the simplicity of the indicator leads to various shortcomings that need to be considered when interpreting the results. First, Indicator 5 is an indirect measure of BEPS and no assertion can be made about the scale of BEPS. Second, royalty payments may not only be linked to R&D spending but also to the use of trademarks, copyrights or franchises (Heckemeyer et al., 2021). Third, it is assumed that MNEs shift IP for tax reasons. However, the definition of the indicator neither provides a direct link to taxes nor does it capture the movement of IP.

Table 12: Indicator 5 – results alternative data

Year	OECD	Base Year: 2011			Base Year: 2017			Base Year: Continuous		
	Indicator	High	Low	Indicator	High	Low	Indicator	High	Low	Indicator
2005	2,8	111%	13%	8,2	78%	14%	5,7	143%	14%	10,5
2006	2,5	112%	14%	8,1	102%	14%	7,3	148%	14%	10,7
2007	2,6	137%	16%	8,8	117%	16%	7,5	182%	16%	11,6
2008	2,5	157%	16%	9,8	89%	16%	5,7	134%	16%	8,6
2009	2,7	148%	14%	10,2	101%	15%	6,9	170%	15%	11,7
2010	4,3	144%	15%	9,4	96%	15%	6,2	144%	15%	9,4
2011	5,8	154%	17%	9,3	101%	17%	6,0	154%	17%	9,3
2012	5,8	160%	17%	9,3	110%	16%	6,7	117%	16%	7,4
2013		164%	16%	10,2	116%	16%	7,2	122%	16%	7,8
2014		198%	17%	12,0	135%	17%	8,1	148%	16%	9,2
2015		197%	17%	11,8	128%	16%	8,1	126%	15%	8,3
2016		156%	16%	10,0	112%	16%	7,1	130%	15%	8,5
2017		166%	17%	9,9	129%	15%	8,4	129%	15%	8,4
2018		179%	16%	11,4	147%	16%	9,0	202%	16%	12,9

Notes: The table depicts the values of Indicator 5. Column 2 shows indicator values estimated by the OECD (OECD, 2015b). For each country the ratio of royalty receipts to R&D spending is calculated. Based on this ratio in a pre-defined base year, countries are assigned to high-ratio groups or low-ratio groups. The threshold values amounts to 50%. Column 3 and 4 show the ratio of the countries in the high-ratio group and low-ratio group, respectively. Column 5 shows the estimated indicator value. Each panel refers to a different base year for group assignment. The Worldbank and OECD are used as data source.

Thus, this indicator could, for example, also proxy R&D productivity by capturing the difference between countries with highly valuable R&D and less valuable R&D. Fourth, the proposed tax planning strategy of transferring IP from R&D countries to low-tax countries may be limited and undesirable since exit-taxation could eliminate potential tax benefits (Ernst and Spengel, 2011). Fifth, even though we try to account for time lags between R&D and IP output in robustness tests, the true time period is unobservable and potentially very diverse. Hence, the indicator variation over time might be misleading. Fifth, this indicator is on the aggregated country level and does not account for country size. Thus, small countries might be overrepresented. Lastly, the group assignment of the indicator depends on an arbitrarily chosen threshold without taking other factors into account.

2.5. Conclusion

Profit shifting of multinational firms is a pressing topic in the public debate, academic research and on the political agenda. Yet, measuring the extent of profit shifting and assessing the economic relevance of it is a major challenge. In its 2015 published Final Report on "Measuring and Monitoring BEPS, Action 11", the OECD has introduced six indicators to measure and evaluate BEPS activity over time and on different levels of aggregation. We replicate one indicator from each of the three subordinate categories and update the numbers underlying the ongoing political debate to reform the global corporate tax system. We build on the conceptual evaluation of the indicators by Heckemeyer et al. (2021) and focus our analysis on the most convincing indicators: Indicator 1 (Disconnect between financial and real economic activities), Indicator 4 (MNE vs. "comparable" non-MNE effective tax rate differentials) and Indicator 5 (Profit shifting through intangibles).

Following the OECD's specification, we closely replicate the estimates of Indicator 1, which intends to indirectly measure BEPS through the use of offshore tax havens. We transparently show that countries with low or no CIT rates or preferential tax systems, e.g., the Bahamas, Cayman Islands or Ireland, have very high concentrations of FDI relative to their

GDP. Extrapolating the indicator to recent years, the net FDI to GDP ratio shows a moderately decreasing trend and the gross FDI to GDP ratio remains at a stable level. The replicated regression estimates of Indicator 4 show that multinational firms have lower effective tax rates than domestic firms. This difference diminishes over time. Our annual estimated ETR differential is lower even in the years that overlap with the OECD sample period. We repeat the analysis using a propensity score matching approach, finding similar results. The replication of Indicator 5, which is concerned with profit shifting through intangibles, shows a stable trend of the annual indicator estimates that extends beyond the OECD's sample period. Similar to the first indicator, we transparently show that countries with high ratios of royalty receipts to research and development (R&D) spending are countries with low corporate income tax rates or IP box regimes, e.g., Ireland, the Netherlands and Luxembourg.

Overall, the OECD's intend to provide a convincing and simple dashboard of indicators that allows to evaluate the existence and scale of BEPS and to measure and monitor how BEPS evolves over time comes with a number of shortcomings. The indicators highly dependent on the underlying assumptions, the availability of data and may be influenced by various confounding factors beyond BEPS. Hence, the informative value of the indicators for policymakers is limited. Yet, transparent updates on the existence and extent of BEPS are important for the ongoing public and academic debate on the necessity to reform the corporate income tax system. We endorse the ongoing empirical research that exploits well-specified identification strategies and granular data to measure the existence and extent of BEPS and propose to tackle the issue from different angles. Only multidimensional approaches allow to develop a holistic view of BEPS and to evaluate ongoing proposals to reform the global corporate income tax system.

3. Internal Digitalization and Tax-Efficient Decision Making[11]

3.1. Introduction

Internal digitalization promises to improve business processes, operations, and communication and ultimately firm performance (Accenture, 2017; Brynjolfsson et al., 2011; PwC, 2020).[12] In particular, decision making in tax departments of firms that belong to a multinational corporation might benefit considerably from digitalization.[13] Prior research has shown that multinational corporations pursue complex tax strategies to shift income from high-tax jurisdictions to low-tax jurisdictions (Buettner and Wamser, 2013; De Simone et al., 2017; De Simone and Sansing, 2019; Huizinga and Laeven, 2008; Huizinga et al., 2008; Markle, 2016; Wagener and Watrin, 2014). By reducing complexity and increasing efficiency, digitalization might be a key enabler for these strategies. Yet, anecdotal evidence suggests that firms are rather hesitant in implementing digitalization in accounting departments (KPMG, 2019). In this study, we examine whether firm's digitalization is an important determinant for tax-induced cross-border income shifting. In addition, we shed light on the specific business software solutions that might facilitate tax strategies to shift income.

We focus on tax-induced income shifting for several reasons. First, building on earlier evidence, we argue that digitalization enables tax departments to monitor and manage global

[11] This section is joint work with Daniel Klein and Katharina Nicolay. We thank David Agrawal, Jannis Bischof, Elisa Casi, Philipp Dörrenberg, Joachim Gassen, Martin Jacob, Richard Kneller (discussant), Jens Müller (discussant), Marcel Olbert, Christoph Spengel, Johannes Voget, the participants of the 113th NTA Annual Conference on Taxation, the TRR 266 Mini Conference on Taxation 2021, the Mannheim Business School Brown Bag Seminar, the seventh annual Mannheim Taxation Conference 2020, and the second joint Walter Eucken Institute and ZEW workshop for their valuable suggestions and comments. We gratefully acknowledge financial support from the Graduate School of Economic and Social Sciences of the University of Mannheim, the Leibniz Association (Taxation in the Era of Digitalization), and from the German Research Foundation (DFG, Project-ID 403041268 – TRR 266).

[12] We define internal digitalization as the availability, accessibility, and usage of sophisticated business software within a firm. Importantly, internal digitalization resulting from investment in digital technologies is independent of the degree of digitalization of a firm's business model or distribution channel. For example, a steel manufacturer might be more digitalized internally than online retailers, social media networks or online search engines, which are commonly perceived as digital firms. In the following, we simply refer to internal digitalization as digitalization.

[13] We define a multinational corporation as a group of at least two affiliated firms (i.e., subsidiaries of a multinational corporation) located in different countries.

and complex value chains, business processes as well as internal capital markets more efficiently (Gallemore and Labro, 2015; McGuire et al., 2018). Second, the performance of tax departments involves the decision rule of maximizing after-tax returns (Robinson et al., 2010; Scholes et al., 2016). Since tax-induced income shifting has an immediate effect on after-tax returns, it is a well-suited measure to draw conclusions on tax departments' performance. Third, the European tax environment with heterogeneous tax rates and many multinational corporations offers an ideal setting to study the determinants of tax-induced income shifting (Hines and Rice, 1994; Markle, 2016).

Based on survey data on European firms' digital technology usage, we directly observe digitalization at the firm level. We create a novel micro-level digitalization index that captures firms' access to up to three key software solutions to digitally monitor and manage firm performance: Enterprise resource planning (ERP) software, database management systems (DBMS) and groupware software. These software solutions are an enabler for advancements in digitalization, such as big data analytics or real-time communication, and provide us with a holistic picture of a firm's level of digitalization. We match our digitalization index with unconsolidated financial data of firms from ORBIS to obtain a rich panel of European firms affiliated to multinational corporations.

We begin our analysis by investigating the association between firm's digitalization and the tax sensitivity of reported profits according to the well-established Huizinga and Laeven (2008) cross-border income shifting estimation approach. The Huizinga and Laeven (2008) income shifting incentive measure (C) indicates a firm's incentive to relocate income to tax-favored jurisdictions. We find evidence on tax-induced income shifting only for digitalized firms. In contrast, we demonstrate that non-digitalized firms do not exploit their income shifting incentives efficiently. The positive association between digitalization and tax-induced income shifting holds if we control for a number of observable firm characteristics, macro controls and a set of fixed effects. The coefficient estimate of our baseline empirical strategy indicates that,

on average, an incremental increase in the level of digitalization increases the reactiveness of reported profits to the income shifting incentive (*C*) by about 50 percent.

Next, we disentangle our granular digitalization index to shed light on which software solution is the main driver of effective tax planning. While the usage of all software solutions seems to facilitate tax-induced income shifting, we find that groupware software has the largest effect on tax-induced income shifting. This suggests that efficient intragroup communication is a key enabler of multinational corporations' effective tax planning. This finding is plausible in light of the growing tax uncertainty from transfer pricing contracts and the internationalization of multinational corporations (Greil et al., 2019; Tan et al., 2020).

We acknowledge that it is possible that observable or unobservable firm-specific characteristics, such as firms' openness to new technological developments or willingness to enter new geographical markets, are associated with both investment in digitalization and cross-border income shifting. It is a choice of firms to invest in digitalization and to engage in income shifting. Hence, endogeneity might be a concern in our setting. We employ a number of additional analyses to mitigate concerns that our findings are partly driven by time-invariant or time-varying, observable or unobservable omitted variables. First, we extend our baseline approach by including firm fixed-effects to control for all time-invariant observable and unobservable firm characteristics and our results remain unchanged. Second, our findings hold in specifications in which we interact all control variables, including the fixed-effects structure, with our variable of interest. The complete interaction controls for differences in observable time-varying firm characteristics. Third, we employ an instrumental variables regression to address concerns that potential time-varying unobservable characteristics affect our results. We use firms' distance to the leading European business software provider and firms' one-year lagged digitalization as instruments for digitalization. Our inferences remain unaffected.

In additional analyses, we examine shocks to firms' income shifting incentives (*C*) and firms' level of digitalization. Both analyses confirm our expectations that more digitalized firms

engage more actively in tax-induced income shifting. Furthermore, we find that multinational corporations with higher levels of digitalization have higher expenditures for tax consultants, potentially backing their tax planning strategies. Finally, we show that the relation between digitalization and income shifting is more pronounced for more complex and internationally dispersed multinationals.

We conduct a battery of robustness tests. Our results remain unaffected if we change the specification of our digitalization index or if we extrapolate the average level of digitalization to all firms of a multinational corporation. Furthermore, our results are robust across several specifications, such as controlling for firms' usage of intellectual property, changing the structure of the income shifting incentive measure or analyzing different tax planning channels of multinational corporations.

Our study relates to three streams of the literature. First, several studies have analyzed the effect of internal information quality on tax planning of firms. McGuire et al. (2018) find a positive association between firm's internal information quality and tax-induced income shifting. They proxy for internal information quality using the speed of earnings announcements and the existence of restatements due to unintentional accounting errors. Gallemore and Labro (2015) show that an increasing quality of firm's internal information environment is associated with lower effective tax rates. They find that tax avoidance activities of geographically dispersed firms and firms operating in uncertain environments benefit more from high internal information quality. Furthermore, Hamilton and Stekelberg (2016) report a negative association of presumably digital firms – i.e., firms that self-select on a magazine's list of 500 firms to signal the usage of information technology – and cash effective tax rates, indicating that firms listed by the InformationWeek magazine avoid more taxes than firms that are not listed by this magazine.

Our research extends these findings along several dimensions. First, we exploit a considerably more granular dataset with firm-level information on investment in digital

technologies. Hence, our measure of digitalization goes beyond mere proxies for the degree of firm's internal information quality or digitalization that have been used in prior studies. Moreover, our detailed information on the components of firm's digital technology usage allows to disentangle the channels that most likely enable efficient tax strategies. Third, we employ an empirical setting that is different to prior studies. The combination of our affiliate-level digitalization index with unconsolidated firm-level accounting data of European firms allows to apply the well-established Huizinga and Leaven (2008) approach to estimate tax-induced cross-border income shifting (De Simone et al., 2017; Markle, 2016). In particular, our analysis is based on a dataset that contains an eleven-year panel and up to more than 28 times the number of observations than prior studies. Furthermore, the cross-sectional and time-varying tax environment in Europe is ideal to analyze cross-border income shifting of firms affiliated to multinational corporations. Overall, our direct link of digitalization and tax-induced income shifting complements prior findings on the association between internal information quality and tax avoidance (Gallemore and Labro, 2015; Hamilton and Stekelberg, 2016; McGuire et al., 2018).

Second, we elucidate the relation between digitalization and effective tax planning decision to provide new insights to the still open question of how digital technologies in non-central business functions change decision making and management practices (Brynjolfsson et al., 2021). Several studies show that investments in digital technology and data-driven decision making positively impact firm performance (Brynjolfsson et al., 2011; Hitt et al., 2002; Melville et al., 2004), but other studies demonstrate that information systems do not necessarily affect firm performance (Li and Sandino, 2018). Analyzing the effect of digitalization in multiple business functions can help to uncover the holistic effect of digitalization on firm performance (Guvenen et al., 2019).

Third, we study digitalization as a mechanism to improve tax planning decisions in terms of a firm's ability to exploit cross-border income shifting incentives. Hence, we also contribute

a novel explanation to the debate on the determinants of tax-induced income shifting (Amberger and Osswald, 2020; Chen, De Simone, et al., 2019; De Simone et al., 2017; Markle, 2016).

The structure of our analysis is as follows. In section 3.2, we outline a simple conceptual framework where firms that promote internal digitalization should, ceteris paribus, engage more in tax-induced cross-border income shifting and relate our analysis to prior evidence. We develop a digitalization index and provide information on our data in section 3.3. Section 3.4 presents the results of our main analysis. In section 3.5, we address potential endogeneity concerns. We conduct additional analyses and perform robustness tests in section 3.6. Section 3.7 concludes.

3.2. Conceptual Framework and Prior Evidence

3.2.1. Decision Making in Tax Departments

The primary tasks and responsibilities of tax departments comprise not only the preparation of annual income tax declarations, ensuring tax compliance, support and consulting of other departments, oversight of transactional taxes but also the management of cross-border, intra-firm transfer pricing contracts (KPMG, 2016). The first listed tasks of tax departments support the core value creation of businesses and are arguably not of central relevance to the profit function of firms. While these tasks are likely to benefit from investment in digitalization[14], the core impact of digitalization is presumably best observed in decisions directly linked to responsibilities that support tax departments' objective function of after-tax profit maximization (Robinson et al., 2010; Scholes et al., 2016). Since multinational corporations operate in various countries that differ in their tax rates, maximizing after-tax profits is achieved by minimizing the tax burden through efficient cross-border income allocation from high-tax countries to low-tax countries. Hence, to analyze whether digitalization leads to better decision

[14] For example, readily available accounting information, stored in fast database management systems, facilitates the preparation of annual income tax declarations and ensures readily available documentation. Seamless invoice management, with highly interconnected enterprise resource planning systems, ensures tax compliance with regard to transaction taxes.

making in tax departments, we measure the effect of digitalization on firms' ability to exploit income shifting incentives by relocating income to tax-favored locations.

Following Scholes et al. (2016), the strategy of tax minimization "requires the planner to consider the tax implications of a proposed transaction for all parties to the transaction." In multinational corporations with global operations, this endeavor may be highly complex, opaque, and costly (Hines and Rice, 1994; Huizinga and Laeven, 2008). Digitalization might help to reduce this complexity leading to improved management decisions on internal transfer prices and financing decisions. Conceptually, we expect better and timelier information on intra-group transactions to reduce the marginal costs of tax-induced income shifting. This implies that for given marginal benefits of income shifting, we should expect an increase in the share of shifted income. In principle, income shifting can be achieved via three channels: transfer price adjustments, debt-shifting and relocation of intangibles (royalty payments). Sophisticated software solutions, such as ERP systems, produce real-time data on internal transactions and enable the tax department to monitor and adjust transfer-prices efficiently. In a similar vein, better information on the status of affiliates' financing situation provides opportunities for tax managers to suggest tax-efficient financing structures. The storage of information and firm-data in well-maintained databases ensures a solid foundation for documentation requirements of fiscal authorities. Groupware communication systems allow a close interaction and information exchange between members of the tax department and managers in cross-border operating sites to manage transfer-pricing contracts and to assess the value of intangibles and associated royalty payments. Since higher digitalization levels can be expected to facilitate all three income shifting strategies, render them less costly and enable a comprehensive view on firms' operations and business processes, we hypothesize that firms with higher levels of digitalization engage more actively in income shifting than firms with lower levels of digitalization.

3.2.2. Prior Evidence on the Effects of Digitalization

We draw on the insights of Brynjolfsson et al. (2011), who explain how more digitalization translates to better information and decision making. The authors demonstrate that digitalization leads to better and more information that, in turn, allows for a more granular knowledge on the potential outcomes of decisions by reducing the noise between the possible results (Brynjolfsson et al., 2011). In addition, firms with sophisticated information processing techniques, provided through digitalization, can convert information into value at lower costs and with greater efficiency (Brynjolfsson et al., 2011; Galbraith, 1974). While several studies evaluate the effect of digitalization on the performance of core business operations (Aral et al., 2012; Li and Sandino, 2018; McAfee, 2002; Müller et al., 2018), it is still an open question how the advantages of more digitalization materialize in better decision making and management practices in non-central business functions (Brynjolfsson et al., 2021). In practice, digital technology systems are usually implemented as holistic solutions that connect central business operations with non-central functions such as the tax department.[15] In theory, this enhanced digitalization should increase the information quality within the tax department, improve processes between affiliated tax departments and, finally, lead to more successful decision making. Ultimately, however, the accuracy of this theory is an empirical question that we hope to answer with this study.

Our analysis also leans on the insights of Gallemore and Labro (2015), Hamilton and Stekelberg (2016) and McGuire et al. (2018). Gallemore and Labro (2015) uncover the association between proxies for internal information quality and tax avoidance, measured by variations in cash effective tax rates. The authors argue that a good information environment allows to uncover tax-reducing opportunities, to coordinate tax planning decisions across different parts of a multinational corporation, to minimize tax risks and to provide acceptable

[15] For example, SAP SE, one of the leading information system providers, advertises its ERP system with the slogan: "Connect all departments and functions with a future-proof ERP system for resilience and operational excellence" https://www.sap.com/products/erp-financial-management.html (accessed: 07/28/20).

documentation for tax authorities (Gallemore and Labro, 2015). However, their study, which is based on U.S. firms, does not disentangle if the effective tax rate reduction stems from national tax avoidance schemes or cross-border tax planning strategies. It also remains questionable which information channel is driving the tax avoidance activities of multinational corporations. McGuire et al. (2018) build on their findings and link proxies for internal information quality, such as earnings announcement speed and lack of accounting restatements, to cross-border income shifting. Yet, U.S. multinationals, that are covered in their study, might have structurally different opportunities for cross-border income shifting than European multinationals and it remains questionable if investments in digital technologies underlie their proxies for internal information quality. Finally, Hamilton and Stekelberg (2016) show that multinational corporations listed in a magazine that promotes digitalized multinational corporations tend to avoid taxes more than firms not listed in this magazine.[16] Again it remains questionable which channels contribute to the reduced effective tax rates that the authors find for presumably digital multinational corporations. Their sample of U.S. based multinational corporations leaves only limited room for a convincing conclusion on the effect of digitalization on cross-border income shifting. We intend to fill this gap in the literature. Our study of a large-scale sample of multinational corporations in Europe, with firm-specific information on their level of digitalization, complements the strand of research that investigates the effects of investment in digitalization.

3.3. Measuring Internal Digitalization

3.3.1. Data and Sample

We exploit the European Aberdeen computer intelligence technology database (CiTDB) to identify firms' usage of sophisticated digital technology. The database comprises detailed and high-quality survey data on the use of digital technology and covers firms across twenty

[16] Multinational corporations apply to be named in the magazine InformationWeek on a list of 500 digital firms.

European countries (Bloom et al., 2016). The Aberdeen Group, which maintains the CiTDB mainly to support sales and marketing decisions of information technology (IT) devices and services distributors, contacts more than 200.000 firms per year and questions high-level IT employees on the current status of a firm's hardware and software usage. Our European Aberdeen CiTDB survey panel covers the years 2005 through 2016 and is restricted to firms with at least 100 employees, which excludes newly founded firms and small firms. However, it is reasonable to assume that firms with more than 100 employees are the most relevant firms for our cross-country empirical analysis. The U.S. version of the database has already been used in several empirical studies in the economics literature to measure different dimensions of digitalization at the micro-level (Bloom et al., 2016, 2014, 2012; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2003; Candel Haug et al., 2016; De Stefano et al., 2017; Forman et al., 2014; Mahr, 2010). Yet, most of these prior studies use data that dates back at least ten years and focus on core digital technology equipment such as computers or IT staff. We are expanding previous literature by creating a digitalization index based on key software solutions that facilitate the use of state-of-the-art digital technologies such as big data management or real-time information exchange.

To evaluate the relation of the firm's digitalization level and the performance of their non-core business functions, we enrich the Aberdeen dataset with detailed financial information. Since the unit of observation in the Aberdeen survey panel is affiliated firm level, we use unconsolidated financial data and ownership information from the Bureau van Dijk's ORBIS database.[17] All unconsolidated firm-level financial data for our sample from 2005 to 2016 is subject to a basic cleaning procedure following Kalemli-Ozcan et al. (2015). We merge

[17] This means that the Aberdeen group does not surveys headquarters of multinational groups to obtain information on the overall group's digitalization level but rather is interested in the affiliates individual level of digitalization. For some firms Aberdeen collects information even at the branch level. Our sample is based on information for firms, i.e., separate legal entities, affiliated to multinational corporations.

the Aberdeen CiTDB to the ORBIS database, based on unique firm names.[18] As we want to investigate the cross-border activities, we keep only affiliated firms in our sample that belong to multinational corporations. We define multinational corporations as a group of affiliated firms with more than 50 percent ownership chains and at least one cross-border relation. In the first step, we keep all affiliated firms of multinational corporations for which we find at least one affiliated firm with a CiTDB to ORBIS concordance in order to calculate the intra-group income shifting incentive measure (*C*) for each affiliate of a multinational corporation. The variable C_{it} is the income shifting incentive measure defined as the operating revenue (*OPRE*)-weighted average tax rate differential of each firm relative to all other affiliated firms per year (Huizinga and Laeven 2008).[19]

After calculating the intra-group income shifting incentive measure (*C*) for each affiliated firm, we only keep affiliated firms for which we observe a direct CiTDB survey response.[20] We do so because anecdotal evidence suggests that the digitalization can differ greatly between firms that belong to the same multinational corporation.[21] In line with our empirical specification, we exclude loss-making firms and firms without sufficient data on our dependent variables. Our final sample consists of 144,796 firm-years, with 24,715 unique firms that belong to 12,216 multinational corporations. See Table 13 for an overview of the sample selection process and Table 14 for the geographic dispersion of our final sample.

Information on effective corporate income tax (CIT) rates are taken from the Taxation and Customs Union Directorate-General database, the Oxford Center for Business Taxation tax database and the EY's Worldwide Corporate Tax Guides. Macro-level control data on the Gross

[18] A simple name matching procedure is the most appropriate method to link the CiTDB firms – due to a lack of a globally applicable identifier – to the ORBIS database.

[19] $C_{it} = \frac{\sum_{k \neq i}^{n} OPRE_{kt} * (CIT_{it} - CIT_{kt})}{\sum_{k=1}^{n} OPRE_{kt}}$, where *i*, *k* and *n* are indicators for a firm, related affiliates and the total number of affiliates per group and year *t*, respectively.

[20] If a firm is not part of the survey wave in a specific year, but the database provides information for preceding and subsequent years, we interpolate the available information.

[21] Our anecdotal evidence relies on consultation with SAP staff on the usage of SAP solutions within multinational groups. In robustness tests we show that even if we assume the digitalization level to be applicable to the complete group, the results remain qualitatively unaffected.

Table 13: Sample selection procedure

Step	Reduction	Remaining observations
Available firm-years in ORBIS (2005-2016)		44,766,410
Basic cleaning according to Kalemli-Ozcan (2015)	-296,607	44,469,803
Groups without any affiliate that has a CiTDB to ORBIS concordance	-37,396,192	7,073,611
Domestic groups	-3,752,434	3,321,177
Firms without CiTDB survey response (digitalization index missing)	-3,105,675	215,502
Firms with losses	-49,178	166,324
Firms without cost of employees	-13,088	153,236
Firms without C measure	-4,644	148,592
Firms without other control variables	-3,796	144,796

Notes: The sample selection procedure starts with the complete set of available firm-years in the BvD ORBIS database and the column reduction depicts the number of firm-years that is lost in each step. The column remaining observations depicts the remaining firm-years after each step, respectively.

Domestic Product (GDP), GDP per capita and unemployment rates are obtained from the World Bank's World Development Indicators database.

3.3.2. The Digitalization Index

We develop a novel index that captures firm's level of digitalization – the digitalization index. For this reason, we combine the CiTDB survey responses on the usage of three different key software solutions to measure a firm's level of digitalization: The usage of an enterprise resource planning (ERP) system, a database management system (DBMS) and groupware software. We focus on these software solutions because they are major technological advances and contribute to the digitalization of firms along different dimensions and are therefore ideal to be combined in a comprehensive index.

An ERP system is a software solution – or a combination of software solutions – that provides detailed information on a firm's resources and activities. In general, ERP systems are adapted to the specific needs of a firm's operations and designed to integrate, optimize and control different stages of the value creation process. Core features of the system usually help multinational corporations to plan and monitor procurement, production, invoicing, human resources and financial reporting. ERP systems have become increasingly important for all

Table 14: Sample geographical dispersion

Country	firm-years	in percent	firms	in percent
Austria	10,324	7.13%	1,506	6.09%
Belgium	11,130	7.69%	1,493	6.04%
Czech Republic	6,118	4.23%	1,065	4.31%
Denmark	4,709	3.25%	723	2.93%
Finland	4,242	2.93%	645	2.61%
France	18,973	13.10%	3,517	14.23%
Germany	21,136	14.60%	3,775	15.27%
Hungary	3,306	2.28%	421	1.70%
Ireland	1,582	1.09%	328	1.33%
Italy	15,621	10.79%	2,448	9.90%
Luxembourg	929	0.64%	165	0.67%
Netherlands	2,408	1.66%	664	2.69%
Norway	2,769	1.91%	500	2.02%
Poland	2,748	1.90%	682	2.76%
Portugal	3,495	2.41%	586	2.37%
Slovak Republic	1,896	1.31%	354	1.43%
Spain	14,054	9.71%	2,197	8.89%
Sweden	1,991	1.38%	397	1.61%
Switzerland	101	0.07%	13	0.05%
United Kingdom	17,264	11.92%	3,236	13.09%
Total	144,796		24,715	

Notes: The table depicts the country dispersion.

kinds of business models and are essential for corporations' digitalization process (Haddara and Elragal, 2015; Hitt et al., 2002). In the last decade, ERP providers, such as SAP or Oracle, have developed applications that allow real-time analysis of processes and offer flexible solutions for small and large businesses. With respect to the tax department, ERP systems have an influence on compliance with direct tax, indirect tax (e.g., value added tax, goods and services tax), and international tax. Integrating taxes into the firm's ERP system saves time and money on recurring tasks while providing an opportunity for tax departments to focus on value-add tasks, such as tax planning.

Database management systems provide access to databases. Databases enable the systematic storage of information and data, maintenance and interaction with information and

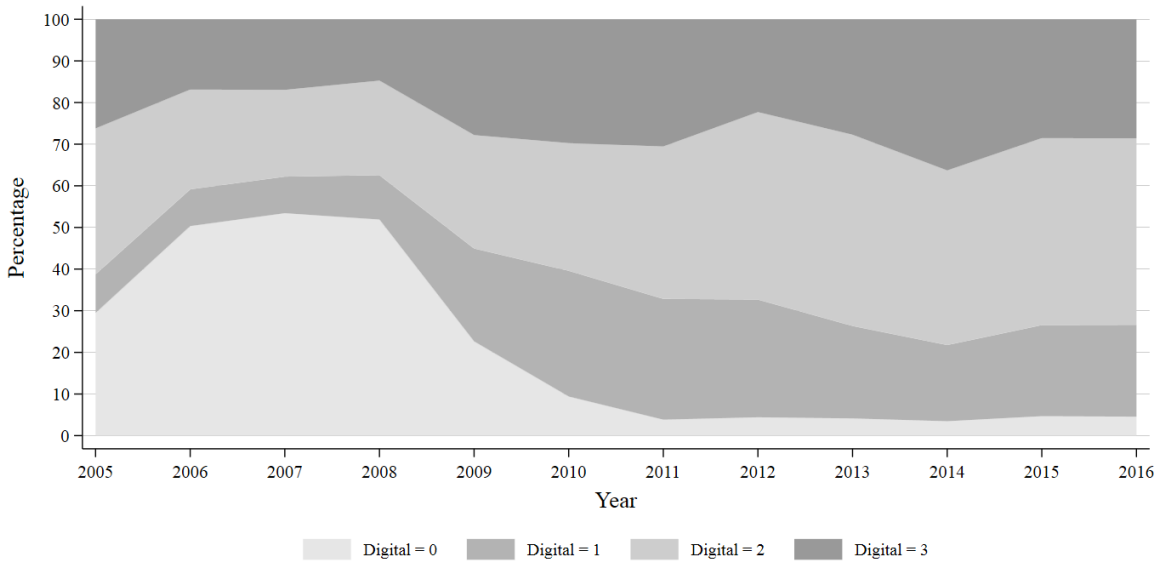
data (Connolly and Begg, 2014). A rigorous information and data management is essential for internal process evaluations and it is a critical infrastructure element to enable big data analytics (Grover et al., 2018). According to Grover et al. (2018), DBMS generate the principal value for big data analytics – that allows real-time business insights and the basis for well-reasoned decision making – by combining different existing and new data sources. Furthermore, well-maintained database management systems ensure the availability and accessibility of data in case of any documentation requests by fiscal authorities. Hence, DBMS is the foundation for the tax department to have real-time information on firms, transactions, costs, products, and accounts across the entire multinational corporation that enable efficient and well-documented transfer pricing strategies and intra-group transactions.

Groupware software enables close interaction and information exchange within a multinational corporation. Prior research has shown evidence on the reduced efficiency of indirect communication via digital channels compared to face-to-face interaction (Hightower and Sayeed, 1995; McGrath and Hollingshead, 1994; Shim et al., 2002). Yet, interactive groupware software, with communication tools such as videoconferencing, can create effective virtual teams that can process information fast and collaborate in a decision making process. Fast internet connections, mobile devices and social networks within firms can support the necessary informal exchange via computer-mediated communication tools (Shim et al., 2002). Groupware software, such as Microsoft Teams, has shown to be a major facilitator of collaboration between dispersed team members in the Corona pandemic. From a tax perspective, groupware software improves group-wide cooperation and maintains the awareness and communication of global tax planning strategies.

We combine all survey responses on the availability of one of the three software categories to create an additive index that ranges from zero, no software is available, to three, the firm uses all software categories. A firm with no access to any of the software categories (indicator equals zero) is considered a non-digitalized firm. Firms with an indicator value of

three, i.e., using all software types, are classified as the most digitalized firms in our sample. The development of the digitalization index composition over time is shown in Figure 9. As one would expect, the number of firms with zero digitalization decreases over time while the number of firms with digitalization index values of two or three increases. In Figure 10, we graphically display the digitalization index composition across industries. The within-industry distribution of the digitalization index is relatively similar across industries. This provides two important insights. First, the internal digitalization of a firm is independent of the business model. Second, our results will not be confounded by the structure of single industries.

Figure 9: Digitalization index development over time



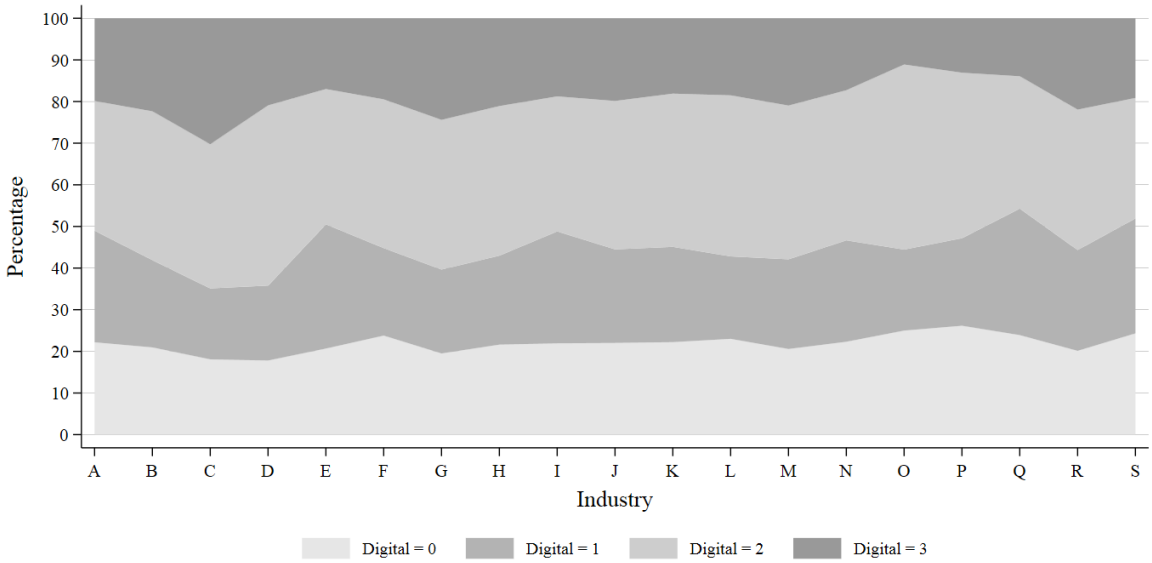
Notes: This figure shows the ratio of firms with a certain digitalization index (Digital) value over time in our baseline sample. In total, the sample contains 144,796 firm-year observations. Over the complete sample period 28,455 firm-year observations have a digitalization index level of 0; 28,290 firm-year observations have a digitalization index value of one; 51,093 firm-year observations have a digitalization index value of two and 36,958 firm-year observations have a digitalization index value of three.

3.4. Results

3.4.1. Descriptive Statistics

Before moving to the regression results, we present descriptive statistics of our sample in Table 15. The full sample of 144,796 profitable firm-years reported a mean (median) pre-tax income of 8.5 million euro (1.6 million euro) and total assets of 123.4 million euro (21.9 million euro). These firms also reported a mean (median) tangible fixed assets of 17.2 million euro

Figure 10: Digitalization index distribution across industries



Notes: This figure shows the ratio of the digitalization index (Digital) level per one digit NACE industry. NACE industries are classified as follows: A = Agriculture, Forestry and Fishing; B = Mining and Quarrying; C = Manufacturing; D = Electricity, Gas, Steam and Air Conditioning Supply; E = Water Supply, Sewerage, Waste Management ; F = Construction; G = Wholesale and Retail Trade; Repair Of Motor Vehicles; H = Transportation and Storage; I = Accommodation and Food Service Activities; J = Information and Communication; K = Financial and Insurance Activities; L = Real Estate Activities; M = Professional, Scientific and Technical Activities; N = Administrative and Support Service Activities; O = Public Administration and Defense; Compulsory Social Security; P = Education; Q = Human Health and Social Work Activities; R = Arts, Entertainment and Recreation; S = Other Service Activities

(2.5 million euro). On average, these firms have an income shifting incentive measure (*C*) of -0.001, representing a weak income shifting incentive to increase profits in the jurisdiction. The median income shifting incentive measure (*C*) is zero. Moreover, we show a correlation matrix for our sample variables in Appendix 3. The digitalization index is not strongly correlated with any observable firm characteristic. To further confirm that our findings will not be confounded by differences in the composition of the digitalization index groups, we show descriptive statistics per group in Table 16. The median firm has access to two software categories. This group consists of 51,093 firm-year observations and represents 35% of the total observations. The digitalization index is zero for less than 20 percent of the sample, and in more than 25 percent of the firm-years, the index has the highest value of three. Importantly, there are no systematic differences in the financial characteristics of the groups.

Table 15: Descriptive statistics

Variable	N	Mean	SD	Minimum	25 percentile	Median	75 percentile	Maximum
EBIT	144,729	6,080	75,371	-11,928,418	526	1,566	4,372	8,055,006
PLBT	144,796	8,528	79,016	0	540	1,646	4,765	9,200,259
Total Assets	144,796	123,400	1,740,348	11	9,522	21,871	56,527	303,805,821
Tangible Fixed Assets (TFAS)	144,796	17,239	138,140	0	533	2,469	8,688	10,899,548
Employee Compensation (STAF)	144,796	12,955	265,205	0	2,714	5,500	11,480	96,241,793
Log(EBIT)	138,824	7.409	1.566	0.038	6.428	7.436	8.432	11.101
Log(PLBT)	144,796	7.347	1.730	0.001	6.294	7.407	8.469	11.603
Log(TFAS)	144,796	7.613	2.114	0.484	6.281	7.812	9.070	12.619
Log(Employee Compensation)	144,796	8.617	1.179	1.103	7.906	8.613	9.348	11.605
Productivity	144,796	0.053	0.025	-0.008	0.037	0.052	0.068	0.138
Log(GDP per Capita)	144,796	3.357	0.352	2.017	3.259	3.442	3.524	4.228
Log(GDP)	144,796	20.533	1.071	17.388	19.572	21.158	21.426	21.773
Unemployment	144,796	8.483	4.185	3.103	5.723	7.719	9.400	24.787
Digitalization index	144,796	1.667	1.061	0.000	1.000	2.000	3.000	3.000
C	144,796	-0.001	0.047	-0.262	-0.010	0.000	0.017	0.294
CIT	144,796	0.296	0.062	0.125	0.250	0.310	0.344	0.403
Distance to SAP	96,205	0.200	0.190	0.000	0.088	0.178	0.268	8.245

Notes: The table depicts the descriptive statistics of all relevant variables. All absolute financial values are stated in thousand euro and the logarithm of it. Unemployment is stated in percent. The income shifting incentive measure (*C*) and the corporate income tax (CIT) are stated in decimals. Distance to SAP is stated in 1000 kilometers. Variables stated in the logarithm are winsorized at the 1 and 99 percentile.

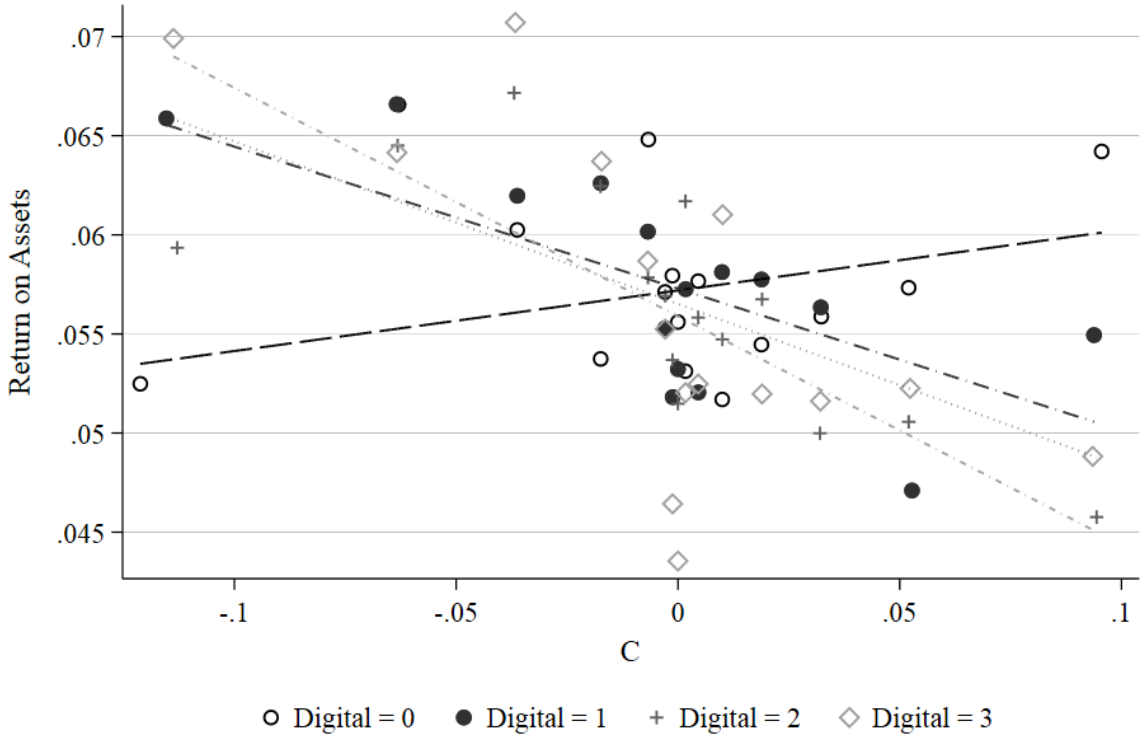
Table 16: Descriptive statistics – disentangled by digitalization index category

Variable	N	Mean	SD	Minimum	25 percentile	Median	75 percentile	Maximum
Digital = 0								
PLBT	28,435	5,892	118,681	-11,928,418	486	1,421	3,992	8,055,006
Log(PLBT)	28,455	7,264	1,734	0,001	6,203	7,313	8,381	11,603
Log(Tangible Assets)	28,455	7,478	2,041	0,484	6,234	7,654	8,858	12,619
Log(Employee Compensation)	28,455	8,510	1,187	1,103	7,826	8,509	9,220	11,605
Consolidated PLBT	4,751	1,164,970	11,274,172	-50,668,400	5,920	32,617	183,511	404,804,352
Total firms per group	4,751	65	266	1	5	12	39	8,838
Digital = 1								
PLBT	28,280	5,803	49,279	-2,073,291	429	1,328	3,776	4,267,220
Log(PLBT)	28,290	7,181	1,762	0,001	6,119	7,241	8,308	11,603
Log(Tangible Assets)	28,290	7,283	2,179	0,484	5,892	7,464	8,791	12,619
Log(Employee Compensation)	28,290	8,457	1,229	1,103	7,720	8,445	9,214	11,605
Consolidated PLBT	1,659	1,620,511	13,108,789	-10,279,526	5,981	37,037	234,676	366,348,672
Total firms per group	1,659	83	268	2	5	14	54	5,588
Digital = 2								
PLBT	51,074	6,545	71,921	-8,935,029	520	1,560	4,390	4,315,849
Log(PLBT)	51,093	7,365	1,735	0,012	6,297	7,413	8,479	11,603
Log(Tangible Assets)	51,093	7,606	2,166	0,484	6,226	7,811	9,108	12,619
Log(Employee Compensation)	51,093	8,629	1,176	1,103	7,911	8,614	9,358	11,605
Consolidated PLBT	3,572	2,426,954	21,151,201	-183,509,680	7,002	44,146	320,645	686,255,168
Total firms per group	3,572	103	388	1	6	14	55	10,226
Digital = 3								
PLBT	36,940	5,796	49,029	-5,001,887	672	1,914	5,122	5,383,014
Log(PLBT)	36,958	7,515	1,677	0,099	6,510	7,584	8,621	11,603
Log(Tangible Assets)	36,958	7,978	1,988	0,484	6,756	8,205	9,336	12,619
Log(Employee Compensation)	36,958	8,806	1,110	1,103	8,137	8,822	9,499	11,605
Consolidated PLBT	2,234	907,302	6,623,156	-16,602,654	5,370	30,612	158,618	218,161,248
Total firms per group	2,234	64	330	1	5	10	33	12,243

Notes: The table depicts the descriptive statistics of all relevant firm characteristics, disentangled by digitalization index category. Consolidated PLBT and total entities per group depict descriptive information on the consolidated level of multinationals. The logarithmic values are winsorized at the 1 and 99 percentile.

We start our analysis by providing a visual impression of the relationship between firms' reported profitability and income shifting incentives conditioned on the level of digitalization. Figure 11 depicts the binned scatterplot following Giroud and Mueller (2019). We use return on assets (RoA), defined as pre-tax profits scaled by total assets, rather than absolute pre-tax profits to take size effects into account and increase comparability. For each digitalization index group, the binned scatterplot clusters the firm-year observations along the x-axis into 15 equally sized bins. To filter out time trends and time-invariant industry characteristics when plotting the association between RoA and the income shifting incentive measure (*C*), we control for time fixed effects and industry fixed effects. For each bin, the binned scatterplot shows the mean value of RoA conditional to our controls.

Figure 11: Descriptive evidence – binned scatterplot



Notes: This figure shows a binned scatterplot. Firms at each digitalization index level are grouped into 15 equally sized bins along the range of the income shifting incentive measure (*C*). The dots depict the average return on assets (in decimals) within each bin at the bin's average *C* value (in decimals) controlling for year- and industry fixed effects. Each shape represents a different degree of digitalization. The plotted lines provide an estimate of the linear relation between the income shifting incentive measure (*C*) and the return on assets. The dashed line depicts digital = 0, the long-dash-dotted line depicts digital = 1, the dotted line depicts digital = 2 and the short-dash-dotted line depicts digital = 3. It controls for year- and industry-fixed effects.

Prior findings suggests that we should observe a clear negative association between RoA and the income shifting incentive measure (*C*), meaning that firms increase reported pre-tax profitability in the jurisdiction when observing a negative income shifting incentive and decrease reported pre-tax profitability in the jurisdiction when observing a positive income shifting incentive (Amberger and Osswald, 2020; De Simone et al., 2017; Huizinga and Laeven, 2008; Markle, 2016). We show that this negative association holds only for digitalized firms. Digitalized firms have, on average, a lower RoA when the income shifting incentive measure (*C*) is negative and a higher RoA when the income shifting incentive measure (*C*) is positive. Thereby, firms in the highest digitalization index group show the steepest slope, followed by firms in the second-highest group and third-highest group. Interestingly, non-digitalized firms even show a slight positive association between pre-tax profitability and the income shifting incentive measure (*C*). This suggests that digitalization is a key factor for firms to observe the most profitable tax planning measures and make efficient decisions.

3.4.2. Digital Infrastructure and Tax-Induced Income Shifting

To measure the impact of digitalization on multinational corporations' income shifting activities, which is one dimension of improved decision making in a firm's tax department, we employ the well-established methodology of Hines and Rice (1994), later extended by Huizinga and Laeven (2008). The model assumes that the total income of an affiliated firm is the sum of true profits, approximated by the Cobb-Douglas production function, and shifted profits. Extending the production function with an income shifting incentive measure allows estimating the responsiveness of the total income to shifting activities. Exploiting this setting allows us to draw first insights on whether digitalized firms shift income more efficiently.

The model is commonly applied in the income shifting literature and still extended by many authors to capture different income shifting determinants (Amberger and Osswald, 2020; Beer and Loeprick, 2015; Chen, De Simone, et al., 2019; De Simone et al., 2017; Markle, 2016). We enhance the model with a measure for firms' level of digitalization:

$$log(PLBT_{it}) = \beta_1 log(TFAS)_{it} + \beta_2 log(STAF)_{it} + \beta_3 log(Prod)_{it} + \beta_4 C_{it} + \beta_5 Digital_{it} + \beta_6 C_{it} * Digital_{it} + \beta_j X_{it} + \eta_t + \mu_{ind} + \varepsilon_{it}\,, \quad (4)$$

where *i* and *t* are indicators for the firm and year, respectively. The dependent variable is the natural logarithm of profit and loss before tax (PLBT) from unconsolidated financial accounts. In line with prior literature, we use the natural logarithm of tangible fixed assets (TFAS) as a proxy for capital, the natural logarithm of employee compensation (STAF) as a proxy for labor and the median return on assets within industry, country and year as a proxy for productivity (De Simone et al., 2017; Markle, 2016). Digital_{it} is the digitalization index. This modification of the standard Huizinga and Laeven (2008) model allows us to evaluate the heterogeneity of profit shifting between firms with different degrees of digitalization. X_{it} is a vector of *j* control variables. In line with the literature on income shifting, we control for the natural logarithm of GDP, the natural logarithm of GDP per capita and the unemployment rate in the firm's host country (Beer and Loeprick, 2015). Further, we follow Gallemore and Labro (2015) and McGuire et al. (2018) and include year fixed effects, η_t and individual industry fixed effects, μ_{ind}. Finally, ε_{it} is an error term. All variables are specified in Appendix 4.

Before testing our hypothesis, we replicate the basic Huizinga and Laeven (2008) regression to provide evidence on the income shifting incentive sensitivity of reported profits in our sample of multinational firms. We estimate a negative and statistically significant coefficient for the income shifting incentive measure (*C*) in Column one of Table 17, which indicates that multinational corporations relocate income to low-tax jurisdictions. In terms of magnitude, our estimate of -0.514 is slightly below the consensus estimate of approximately -0.8, but in line with estimates using samples of more recent time periods (Dharmapala, 2014; Heckemeyer and Overesch, 2017). As expected, we also show that the estimates of the Cobb-Douglas coefficients, capital, labor and productivity, have a positive and statistically significant

effect on firms' profitability. Our estimates on the country control variables are, in general, also in line with the expected direction.

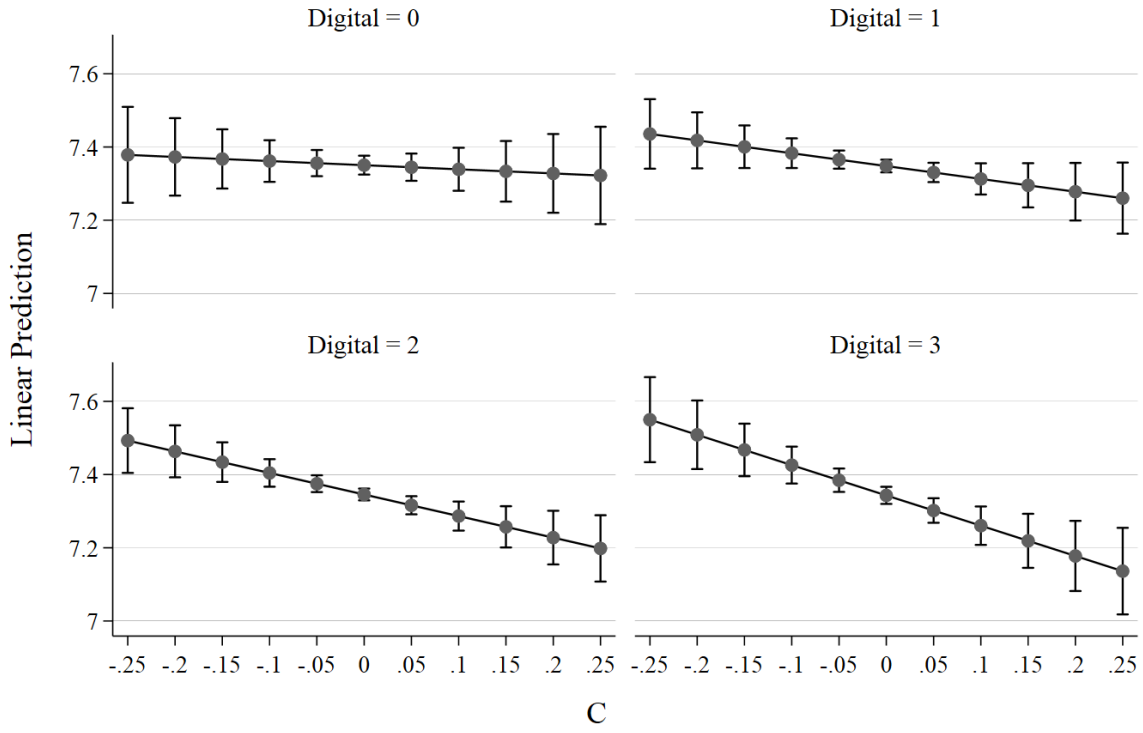
Table 17: Baseline results

	Dependent Variable: Log(PLBT)			
Variable	(1)	(2)	(3)	(4)
C x Digital		-0.238**	-0.171*	-0.315**
		(0.118)	(0.091)	(0.135)
C	-0.514***	-0.113	0.322	0.031
	(0.176)	(0.264)	(0.250)	(0.291)
Digital		-0.002	0.004	
		(0.007)	(0.005)	
Log(Tangible Assets)	0.158***	0.158***	0.042***	0.171***
	(0.006)	(0.006)	(0.007)	(0.010)
Log(Employee Compensation)	0.677***	0.677***	0.412***	0.638***
	(0.011)	(0.011)	(0.020)	(0.017)
Productivity	4.456***	4.444***	8.660***	3.920***
	(0.343)	(0.343)	(0.273)	(0.558)
Log(GDP per Capita)	0.090***	0.091***	0.245	0.036
	(0.027)	(0.027)	(0.342)	(0.044)
Log(GDP)	0.008	0.007	-0.539*	0.025*
	(0.008)	(0.008)	(0.326)	(0.014)
Unemployment	-0.006***	-0.006***	-0.013***	-0.016***
	(0.002)	(0.002)	(0.003)	(0.004)
Digital x Log(Tangible Assets)				-0.008
				(0.005)
Digital x Log(Employee Compensation)				0.024***
				(0.009)
Digital x Productivity				0.300
				(0.269)
Digital x Log(GDP per Capita)				0.030
				(0.020)
Digital x Log(GDP)				-0.010
				(0.006)
Digital x Unemployment				0.005***
				(0.002)
Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x	x		x
Firm Fixed Effects			x	
Interaction of fixed effects	.	No	No	Yes
Observations	144,796	144,796	141,949	144,796
Number of firms	24,715	24,715	21,868	24,715
R2 (within)	0.350	0.350	0.043	0.346

Notes: This table presents the regression results for the baseline approach for 144,796 firm-years of European affiliates of multinational corporations. C is the income shifting incentive measure as defined by Huizinga and Laeven (2008). Columns two to four include a novel measure for the digitalization of firms. The digitalization index (Digital) is determined as an additive index that captures if a firm has access to an ERP software, a database management system (DBMS) or groupware software. It is based on a yearly survey over the period 2005 to 2016. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Column two to four in Table 17 provide the baseline results for the expected association between internal digitalization and cross-border income shifting. The coefficient of interest is the interaction of the income shifting incentive measure (*C*) and the digitalization index. We estimate an interaction coefficient of -0.238. Compared to our baseline estimate without controlling for digitalization this translates, on average, to an increase of tax-induced profit shifting by about 50 percent per incremental improvement in the digitalization level.[22] Figure 12 provides graphical evidence on the estimated profitability at different levels of digitalization for firms with different incentives to relocate income. The upper panel shows firms with a digitalization index of zero or one. The estimates indicate a moderate tax sensitivity of reported profits that is not statistically significant for non-digitalized firms. As depicted in the lower panel, the profits of firms with digitalization levels of two or three are more sensitive to the

Figure 12: Tax sensitivity at different digitalization index levels



Notes: The figure depicts the predictive margins of the logarithm of PLBT over the income shifting incentive measure (*C*) range for different levels of the digitalization index, based on our baseline estimation approach: $\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 C_{it} + \beta_5 Digital_{it} + \beta_6 C_{it} * Digital_{it} + \beta_j X_{it} + \eta_t + \mu_{ind} + \varepsilon_{it}$. The vertical lines represent the 95% confidence intervals.

[22] We calculate the ratio of the interaction coefficient in column two of Table 17 relative to the baseline estimate in column 1 of Table 17: -0.238/-0,514=0,463

income shifting incentive measure. A negative slope indicates that firms relocate income towards low-tax jurisdictions, which is an outcome of effective tax planning decisions. The slope is steepest for firms with the highest value of our digitalization index.

In order to mitigate possible unobserved firm-specific effects that are relatively constant over time, we include firm fixed effects in column three of Table 17. As expected, we still find that the level of digitalization enhances tax-induced income shifting. Further, our digitalization index might capture structural differences between firms such as size or profitability. In the last column of Table 17 we modify our estimation approach to addresses this concern. We fully interact all variables with our variable of interest, the digitalization index. In our preferred and most comprehensive specification, we still find an interaction coefficient of -0.315. The statistically significant coefficient implies that firms with an incrementally higher level of digitalization exhibit a 0.315 percentage point stronger tax responsiveness of reported profits. The effect of digitalization on income shifting is economically significant. The estimate implies a combined semi-elasticity of -0.284 (0.031+ -0.315 = -0.284) for a one level increase in the level of digitalization. This implies that if the income shifting incentive decreases by ten percentage points, e.g., from 0.2 to 0.1, the natural log of profit and loss before tax increases by 2.84 percent for each additional level of digitalization. At the mean PLBT, this corresponds in absolute terms to an estimated increase of reported profits in the tax rate reducing jurisdiction by more than 0.700 million euro if non-digitalized firms fully digitalize.[23]

The interaction coefficients of our digitalization index and the firm-specific control variables reveal that the level of digitalization only seems to be associated positively with staff expenditure. It is very plausible that digitalized firms employ more skilled employees to manage and monitor their systems. The level of digitalization does not seem to capture any other structural differences between firms. Hence, our results indicate that the degree of

[23] The average firm has a PLBT of 8.528 million euro. $8.528 * (0{,}0284 * 3) = 0.726$ million euro

digitalization is an additional facilitator of tax-induced income shifting, which goes beyond the mere size of firms or their business model.[24]

3.4.3. Disentangling the Software Categories

Our measure of digitalization goes beyond mere proxies of the degree of firm's internal information quality and perceived digitalization that have been used in prior studies. The granular information on the components of firm's digital technologies allows to uncover the association of specific digital technologies and income shifting. Gallemore and Labro (2015) argue that a good information environment allows to uncover tax-reducing opportunities, to coordinate tax planning decisions across different parts of a firm, to minimize tax risks and to provide acceptable documentation for tax authorities. Each of the digital technologies underlying our digitalization index facilitates one of these channels. Enterprise resource planning software provides opportunities to monitor transactions in real time and to optimally adjust transfer pricing. Groupware software facilitates communication between managers in different parts of a firm and to negotiate tax planning strategies that include the reallocation of reported income. Database management software, that helps to systematically store information and data, facilitates to comply with tax authorities' documentation requirements.

We re-estimate our baseline estimation but replace the digitalization index by three separate dummy variables that indicate the availability of either ERP software, DBMS systems or groupware software at the firm. We control for the availability of the alternative digital technologies in our estimations. Otherwise, the estimation remains equivalent to our baseline approach. Table 18 depicts the results of the analysis of the effect of separate digital technologies.

[24] In robustness tests, we include the ratio of intangible to total assets as an additional control variable to control for this very specific channel of cross-border tax planning (De Simone et al., 2016; Dischinger and Riedel, 2011). See section 3.6.5.

Table 18: Disentangling the software categories

	Dependent Variable: Log(PLBT)		
Software category:	Groupware	DBMS	ERP
Variable	(1)	(2)	(3)
C x Software	-0.558**	-0.143	-0.417
	(0.267)	(0.269)	(0.258)
C	-0.156	-0.406	-0.294
	(0.229)	(0.250)	(0.220)
Groupware	-0.031	-0.059**	-0.008
	(0.026)	(0.027)	(0.023)
DBMS	0.027	0.065**	0.084***
	(0.027)	(0.026)	(0.023)
ERP	0.103***	0.087***	0.098***
	(0.028)	(0.028)	(0.031)
Log(Tangible Assets)	0.171***	0.171***	0.171***
	(0.010)	(0.010)	(0.010)
Log(Employee Compensation)	0.636***	0.636***	0.635***
	(0.017)	(0.017)	(0.017)
Productivity	3.890***	3.851***	3.876***
	(0.556)	(0.557)	(0.557)
Log(GDP per Capita)	0.043	0.051	0.050
	(0.044)	(0.044)	(0.044)
Log(GDP)	0.029**	0.032**	0.031**
	(0.014)	(0.014)	(0.014)
Unemployment	-0.016***	-0.015***	-0.015***
	(0.004)	(0.004)	(0.004)
Software x Groupware		0.060*	-0.047
		(0.031)	(0.029)
Software x DBMS	0.072**		-0.036
	(0.032)		(0.029)
Software x ERP	-0.072**	-0.049*	
	(0.030)	(0.029)	
Software x Log(Tangible Assets)	-0.008	-0.008	-0.008
	(0.005)	(0.005)	(0.005)
Software x Log(Employee Compensation)	0.024***	0.025***	0.025***
	(0.009)	(0.009)	(0.009)
Software x Productivity	0.322	0.346	0.331
	(0.268)	(0.268)	(0.268)
Software x Log(GDP per Capita)	0.026	0.023	0.025
	(0.020)	(0.020)	(0.020)
Software x Log(GDP)	-0.013**	-0.015**	-0.014**
	(0.006)	(0.006)	(0.006)
Software x Unemployment	0.005***	0.005**	0.005***
	(0.002)	(0.002)	(0.002)
Year Fixed Effects	x	x	x
Industry Fixed Effects	x	x	x
Interaction of fixed effects	Yes	Yes	Yes
Observations	144,796	144,796	144,796
Number of firms	24,715	24,715	24,715
R2 (within)	0.347	0.347	0.347

Notes: This table presents the regression results for estimating the baseline equation for each software category (ERP software, a database management system (DBMS) or groupware software) separately. All other specifications are as in Table 17. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Our results indicate that each of the three different digital technologies that constitute our digitalization index is associated with more tax-induced income shifting. The association is statistically significant only for the availability of groupware software. We perceive this finding as very plausible for two reasons. First, the growing relevance of intangible transactions has made transfer pricing arrangements more and more complex in multinational corporations and a major source of tax uncertainty (Greil et al., 2019). Second, multinational corporations become larger and the increasing relevance of intangible resources promotes the internationalization of multinational corporations (Tan et al., 2020). In this vein, our results indicate that among the information channels discussed by Gallemore and Labro (2015), coordination of tax planning across different parts of a firm seems to be a key enabler of tax strategies to shift income.

3.5. Instrumental Variables Approach

The results of our baseline estimation approach provide evidence on the association between digitalization and tax-induced income shifting. We find our regression results to be robust to the inclusion of firm fixed effects and the full interaction of all variables with our digitalization index. However, we acknowledge that it is possible that unobserved and time-varying firm-specific characteristics are associated with both investment in digital infrastructure and cross-border income shifting opportunities. We use an instrumental variables regression approach to directly address this endogeneity concern.

As a first instrument, we use the distance between the firm and a regional SAP office. It is reasonable to assume that the distance to a regional SAP office is inversely correlated to the implementation of digital technologies (satisfying the inclusion criteria). SAP is the largest European developer and distributor of digital technologies for firms and has at least one regional office in each European state. The close proximity of SAP sales people to regional firms creates opportunities, e.g., at informal events or in local sports clubs, to convince decision makers at local firms to invest in digitalization. However, the distance between SAP regional

offices and firms is unlikely to have a direct effect on reported profits (satisfying the exclusion criteria).

In line with prior studies on the effect of digitalization on firm performance, the second instrument exploits the panel structure of our data and uses lagged values of the digitalization index as a valid instrument (Bloom et al., 2012; Cardona et al., 2013; Han and Mithas, 2013; Tambe and Hitt, 2012). While the lagged variables of the digitalization index (t-1) are closely related to the digitalization index in year t (satisfying the inclusion criteria), they should not have a direct effect on the reported profitability in year t (satisfying the exclusion criteria).

We report the results of the instrumental variables regression in Table 19. The first stage regression reveals that there is a strong negative association between the distance to a regional SAP office and the level of digitalization. Further, we find a positive relation of the degree of digitalization in the preceding year on our digitalization index. In line with Shevlin et al. (2019), we conduct a number of tests to confirm that our choice of instruments is valid and that our model is fully identified. The test for whether the model is under-identified (Kleibergen-Paap LM test), which is rejected at the one percent level, implies that our instruments are strongly correlated with the digitalization index. The reported F-statistic of 11,308, which stand in contrast to the 10 percent Stock and Yogo (2005) critical value of 16.87, rejects the null hypothesis that our instrumental variables are only weakly correlated with the digitalization index (Kleibergen-Paap Wald F test). Finally, we conduct an overidentifying restrictions test. The reported p-value of our Hansen's J statistic does not allow to reject the null hypothesis that the excluded instruments are exogenous. These tests indicate that our model is fully identified and that we use valid instruments.

As expected, we find a negative and statistically significant interaction coefficient of our instrumented digitalization index and the income shifting incentive measure (*C*) in our second stage regression. The magnitude of the estimated interaction coefficient (-0.349) is in line with our baseline regression results reported in Table 17.

Table 19: Instrumental variables approach

	First Stage	Second Stage
	Dependent Variable = Digitalization index	Dependent Variable = Log(PLBT)
Variable	(1)	(2)
C x Digital		-0.351*
		(0.190)
Digital		-0.012
		(0.011)
C	-0.761***	0.112
	(0.117)	(0.411)
Log(Tangible Assets)	0.004***	0.165***
	(0.001)	(0.008)
Log(Employee Compensation)	0.020***	0.669***
	(0.002)	(0.015)
Productivity	0.219*	4.797***
	(0.115)	(0.434)
Log(GDP per Capita)	-0.050***	0.096***
	(0.007)	(0.034)
Log(GDP)	-0.006***	0.008
	(0.002)	(0.010)
Unemployment	-0.004***	-0.007**
	(0.001)	(0.004)
Distance to SAP	-0.063***	
	(0.012)	
$Digital_{(t-1)}$	0.779***	
	(0.003)	
C x Distance to SAP	0.995***	
	(0.157)	
C x $Digital_{(t-1)}$	0.249***	
	(0.051)	
Year Fixed Effects	x	x
Industry Fixed Effects	x	x
Observations	85,705	85,705
Number of firms	15,174	15,174
R2	0.629	0.358
Kleibergen-Paap LM statistic	3,795.80	
(p-value)	(0.000)	
Kleibergen-Paap F statistic	11,803.40	
Hansen's J statistic		3.443
(p-value)		(0.179)

Notes: This table reports instrumental variable regression results for analyses that examine the effect of internal digitalization on tax-induced cross-border income shifting. In the second stage regressions, $Digital_{it}$ is instrumented by Distance to SAP_{it} and by $Digital_{it-1}$. Distance to SAP_{it} is the distance between the firm and the nearest local SAP retailer in 1000 kilometers. $Digital_{it-1}$ is the digitalization index in year t-1. C is the income shifting incentive measure as defined by Huizinga and Laeven (2008). All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

The instrumental variables regression approach indicates that the association between digitalization and tax-induced income shifting is robust to concerns that our findings are partly driven by omitted variables and endogeneity.

Overall, the combined results of our baseline estimation approach and our additional instrumental variables analysis complement and validate our prior understanding on the relationship between digitalization and decision making with regard to income shifting in a firm's tax department. We enhance our findings and conclusions in the next section by examining shocks to firms' income shifting incentives (*C*) and firms' level of digitalization, additional associations, heterogeneity analyses and robustness tests.

3.6. Additional Analyses and Robustness Tests

3.6.1. Reaction to Tax Incentive Changes

In our first alternative estimation approach, we use shocks to the income shifting incentive measure (*C*) as an identification strategy. The main determinant of the income shifting incentive measure (*C*) is the tax rate differential between firms of a multinational corporation. Any statutory corporate income tax rate change has an immediate effect on the measure if the multinational corporation has a firm in the country that enacts a tax reform. For example and anything else equal, a large tax rate reduction of more than ten percentage points – as in the United States after the 2017 Tax Cuts and Jobs Act and after the 2008 German Corporate Tax Reform – heavily reduces the incentive to relocate income towards low tax jurisdictions, because it changes the relative attractiveness of low-tax countries. Hence, we expect that a strong negative shock to the income shifting incentive measure should lead to an increase in the firm's reported profits. Our sample of European firms is ideal for this approach as many European countries have lowered their statutory corporate income tax rates during the sample period. We apply an event study approach and estimate the following specification:

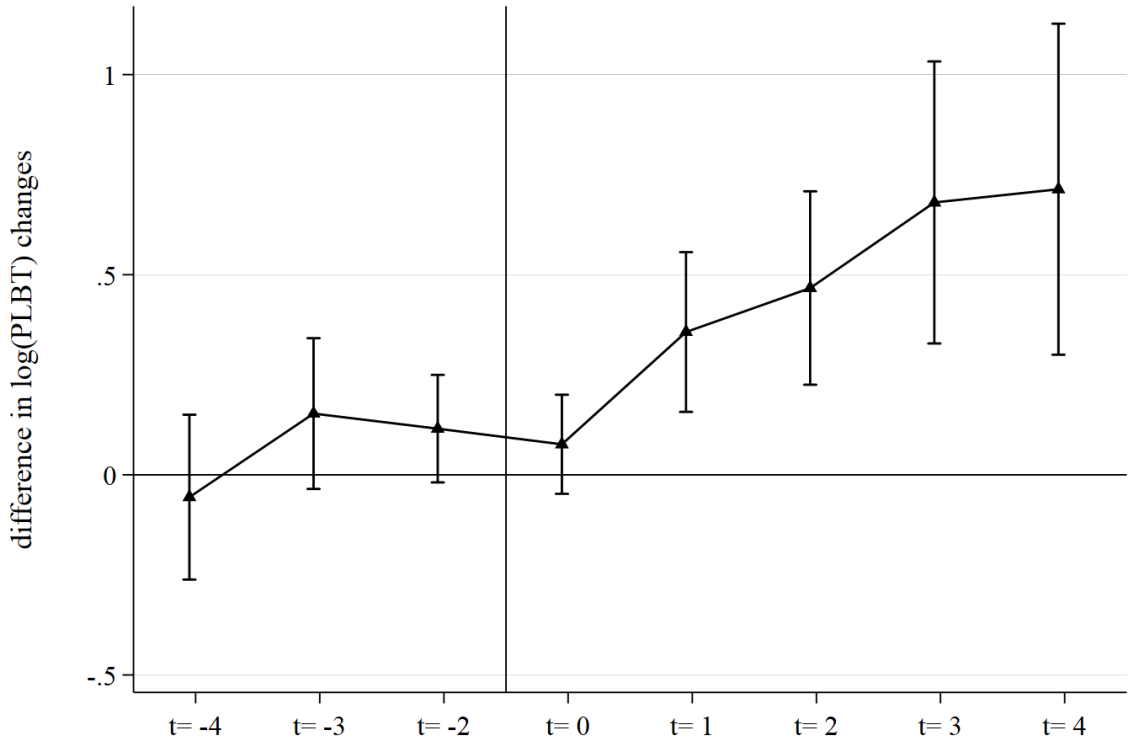
$$log(PLBT_{it}) = \beta_1 log(TFAS)_{it} + \beta_2 log(STAF)_{it} + \beta_3 log(Prod)_{it} + \beta_4 Treat\_Digital_i + \beta_5 Post_t + \beta_6 Treat\_Digital_i * Post_t + \beta_j X_{it} + \eta_t + \mu_{ind} + \varepsilon_{it}, \quad (5)$$

where $Treat\_Digital_i$ is a dummy variable that takes the value of one if a firm belongs to a multinational corporation with access to digital technologies, i.e., a multinational corporation that has an affiliated firm with an digitalization index value above one, and zero for firms in multinational corporations with affiliated firms that only have a digitalization index value of zero. $Post_t$ is a dummy variable that takes the value of one in the periods after the shock to the income shifting incentive and zero otherwise. For the event study specification, we replace $Post_t$ with annual dummy variables. All other variables are defined as in the baseline estimation approach.

Our baseline sample provides the most precise measure of firms' degree of digitalization because it only comprises firms for which we have survey responses from the Aberdeen CiTDB survey. This strict data-driven restriction considerably reduces our sample by more than 90 percent (see Table 13) relatively to the sample of firms that belong to a group for which we can find at least one firm with Aberdeen CiTDB information. For the event study approach, we intend to use all available financial information of this group of firms. Hence, we adjust our sample in a similar vein as Bilicka and Scur (2021). To receive a conservative estimate for a group's investment in digitalization, we assign the minimum digitalization index score per multinational corporation to all firms within that multinational corporation for which we have financial data. This sample is equivalent to the sample used to calculate the income shifting incentive for each affiliate per year. We determine a shock to the income shifting incentive variable (*C*) as an income shifting incentive change in the lowest decile of changes. We limit the sample to firms that are once subject to a shock to the income shifting incentive and keep all years pre and post the shock of this firm. The sample consists of 59,617 firm-years, with 10,317 unique firms, and thereof 2,276 firms are assigned to have a digitalization index value of zero.

Figure 13 plots the annual event study coefficients. Prior to the negative income shifting incentive shock, the annual change in reported profits does not differ between internally digitalized firms and non-digitalized firms. In response to the negative tax incentive shock, however, reported profits of digitalized firms increase significantly more than reported profits of non-digitalized firms. This result is in line with our expectation that decision makers in groups with a high degree of digitalization have the capabilities to quickly react to changes in external circumstances and tax-induced income shifting incentives. Table 20 depicts the coefficient estimates of the regression analysis. In line with the graphical event study analysis, the statistically significant positive interaction coefficient indicates that digitalized firms

Figure 13: Change in PLBT in response to negative income shifting incentive changes



Notes: The figure depicts the difference in reported income (profit and loss before tax, PLBT) changes between digitalized and non-digitalized firms, for firms that experience a large negative change in the income shifting incentive measure (*C*). PLBT is transformed to its logarithm. We classify large changes as those in the lowest decile of all firms for which we can determine the income shifting incentive measure (*C*). This analysis uses a modified sample. The modified sample is based of all firms with CiTDB survey responses and their affiliates. Affiliates within this group are classified as digitalized if the group has on average a digitalization index value of above one and non-digitalized otherwise. The sample is limited to firms that are subject to a change in the lowest decile of the income shifting incentive measure (*C*) changes (i.e. the large negative C change indicates that multinationals have incentives to report more income at the firm that now has lower C measure). Year 0 is classified as the year in which the large negative C change occurs. Year -1 is set as the base year and excluded from our graphical representation, all other years are measured relative to year -1.

Table 20: Reaction to a negative shock of the income shifting incentive measure

	Dependent Variable: Log(PLBT)	
Variable	(1)	(2)
Post x Treat Digital	0.123**	0.043
	(0.058)	(0.043)
Post	-0.046	0.038
	(0.059)	(0.044)
Treat Digital	0.097**	-0.068**
	(0.039)	(0.027)
Log(Tangible Assets)	0.176***	0.026***
	(0.008)	(0.009)
Log(Employee Compensation)	0.640***	0.385***
	(0.012)	(0.023)
Productivity	4.599***	7.991***
	(0.529)	(0.443)
Log(GDP per Capita)	-0.003	-0.203
	(0.034)	(0.434)
Log(GDP)	0.037***	0.549
	(0.014)	(0.421)
Unemployment	-0.005	0.008
	(0.003)	(0.005)
Year Fixed Effects	x	x
Industry Fixed Effects	x	
Firm Fixed Effects		x
Observations	59,617	58,340
Number of firms	10,317	9,040
R2 (within)	0.493	0.047

Notes: This table presents the results for the reactiveness of firm to a relatively large downward changes in the income shifting incentive variable (*C*). Treat Digital is a dummy variable that takes the value of one if a firm belongs to a group that has access to an ERP software, a database management system (DBMS) or groupware software and zero for firms in groups without these technologies. Post is a dummy variable that takes the value of one in the periods after the C shock and zero otherwise. The sample is limited to firms that experience a negative C shock that is in the lowest decile of C changes. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

increase their reported income after a large negative shock to the income shifting incentive more than non-digitalized firms.

3.6.2. Reaction to the Availability of a New Software Solution

In our second alternative estimation approach, we exploit a change on the market for digital technology to further link firms' level of digitalization with the efficiency of cross-border tax planning decisions. In particular, we exploit the first release of a comprehensive business software solution bundle by the European market leader SAP in 2009.[25] One product of this

[25] For more information on the business software solution, see https://news.sap.com/uk/2009/05/sap-business-suite-7-now-available-to-customers-worldwide/ (accessed: 11/26/2020).

bundle is an ERP solution. We conduct a generalized difference-in-differences analysis to measure whether firms that implement an ERP software solution for the first time after the market release make more efficient income shifting decisions than firms that do not have access to an ERP system.[26] We estimate the following specification for the period 2005 to 2013:

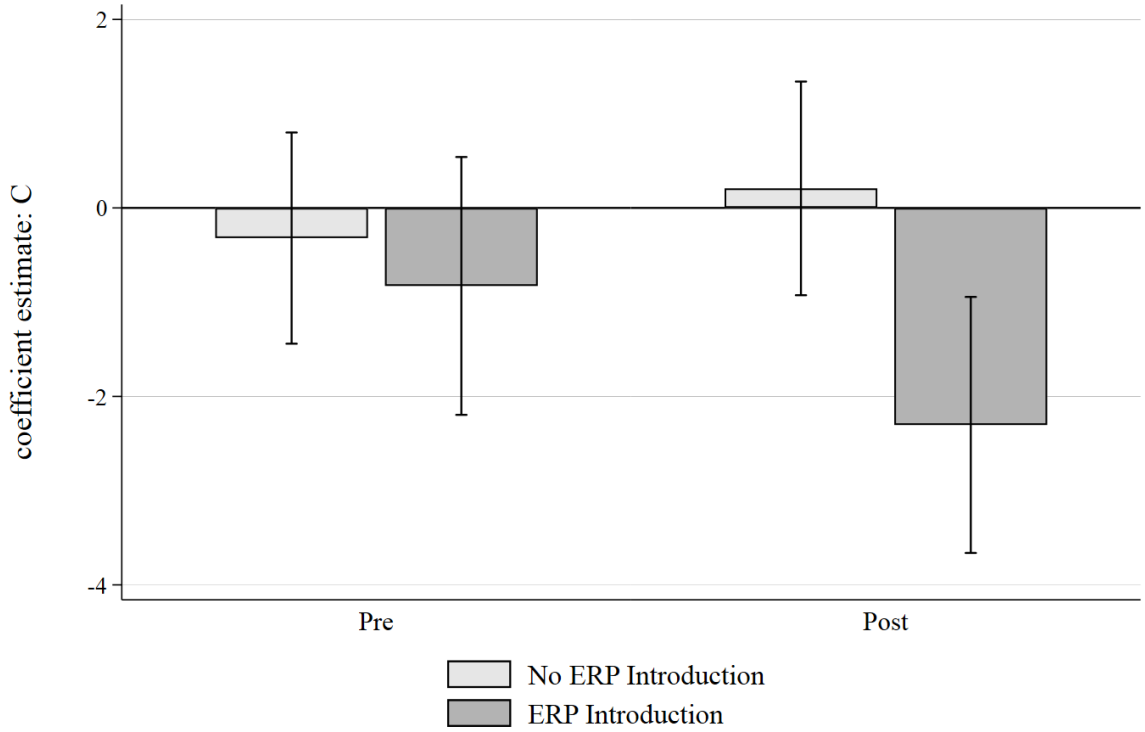
$$log(PLBT_{it}) = \beta_1\, log(TFAS)_{it} + \beta_2\, log(STAF)_{it} + \beta_3\, log(Prod)_{it} + \beta_4 C_{it} * ERP\_update_t + \beta_5 C_{it} * ERP\_update_t * ERP\_introduction_i + \eta_t + \mu_{ind} + \varepsilon_{it}. \quad (6)$$

$ERP\_introduction_i$ is a dummy variable that takes the value of one for firms that implement an ERP system for the first time in 2009 or 2010 and zero for firms that never introduce any software solution. ERP_update_t is a dummy variable that takes the value of one for years as of 2009 and zero otherwise. All other variables are defined as in the baseline estimation approach. We use 2009 and 2010 as event years as the roll-out of new software solutions is a staggered process. The sample consists of 36,006 firm-years, with 5,809 unique firms and thereof 2,191 firms introduce an ERP system. In line with our hypothesis, we expect β_5 to be negative, i.e., firms that introduce the new business software solution package are expected to engage more actively in cross-border tax planning.

Figure 14 graphically depicts the estimated coefficients of the income shifting incentive measure for treatment and control firms pre and post to the software introduction. The graphical evidence highlights that prior to the software implementation, in the period of 2005 to 2008, tax-induced income shifting is indistinguishable from zero for either group. Only for firms that have introduced an ERP software solution in 2009 or 2010, we find a significant negative coefficient estimate in the period after the update. Our regression results in Column one of Table 21 show that tax-induced income shifting is, indeed, significantly stronger for treated

[26] We acknowledge that we do not specifically observe whether the implemented ERP system is an SAP ERP system. However, since we only consider European firms and SAP is the European market leader that just offered a new product, we assume that all firms that implement a new ERP solution after 2009 implement the new SAP version. See https://news.sap.com/2012/05/sap-named-worldwide-market-share-leader-for-enterprise-resource-planning/ (accessed: 11/26/2020).

Figure 14: Tax sensitivity after ERP introduction



Notes: In 2009, SAP, the largest European ERP provider, released an updated and comprehensive ERP business software solution. The figure depicts the coefficients of the income shifting incentive measure (*C*) pre and post to the availability of the updated ERP version disentangled by groups that introduce an ERP software solution and those that never introduce an ERP software solution. The estimates of the income shifting incentive measure (*C*) are based on the following regression: $\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 C_{it} + \eta_t + \mu_{ind} + \varepsilon_{it}$. We conduct the regression four times. First, for firms that never introduce an ERP system prior to the SAP update. Second, for firms that introduce an ERP system in 2009 or 2010 prior to the introduction. Third, for firms that never introduce an ERP system after the SAP update. Fourth, for firms that introduce an ERP system in 2009 or 2010 after the SAP update. The statistical difference between the four groups is tested in Table 21. The vertical lines represent the 95 percent confidence intervals.

firms after the release of a new business software solution package. These results shed light on the effect of the introduction of a new digital technology on the tax-induced income shifting decisions of multinational corporations. It corroborates our hypothesis that that firms with higher digitalization levels engage more actively in cross-border income shifting to increase firm profitability than firms with low digitalization levels.

3.6.3. Payments to Tax Consultants

Prior literature has identified that the utilization of tax consulting services is related to corporate tax planning (Armstrong et al., 2012; Klassen et al., 2016; Wilde and Wilson, 2018). The services of external tax consultants with respect to income shifting include, for example, the

Table 21: Reactiveness of firms to a change in the digitalization level

	Dependent Variable: Log(PLBT)	
Variable	(1)	(2)
C x ERP update x ERP introduction	-2.381***	-1.329**
	(0.791)	(0.661)
C x ERP update	0.480	-0.444
	(0.525)	(0.489)
C	-0.363	0.999**
	(0.417)	(0.438)
Log(Tangible Assets)	0.175***	0.027**
	(0.012)	(0.013)
Log(Employee Compensation)	0.668***	0.413***
	(0.021)	(0.039)
Productivity	3.324***	8.171***
	(0.675)	(0.543)
Log(GDP per Capita)	0.135**	0.147
	(0.055)	(0.701)
Log(GDP)	0.007	-0.152
	(0.018)	(0.717)
Unemployment	-0.013***	-0.015***
	(0.004)	(0.005)
Year Fixed Effects	x	x
Industry Fixed Effects	x	
Firm Fixed Effects		x
Observations	36,006	35,688
Number of firms	5,809	5,491
R2 (within)	0.333	0.040

Notes: The table presents the results for the changes in firm's tax responsiveness of reported profits in response to the adoption of an ERP software in 2009 or 2010. ERP introduction is a dummy variable that takes the value of one if a firm introduces an ERP software solution in 2009 or 2010 and zero if a firm never introduces any software solution. Post is a variable that takes the value of one for the years 2009 to 2013 and zero for the years 2005 to 2008. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

setup of organizational and financial structures or the provision of necessary documentation of intra-group transactions. Also, tax consultants play an important role in the context of tax risk management (Cools and Rossing, 2020). In order to exploit the observed tax planning opportunities, digitalized firms are likely to have a higher demand for these services and, hence, we expect that digitalized firms pay relatively higher amounts to tax consultants than non-digitalized firms.

Firms listed on a European Economic Area stock exchange are required to disclose tax fees paid for tax consulting services to the firm's external auditor in the notes to the consolidated

financial statements.[27] We use the Audit Analytics Europe database to obtain these data for listed firms for the years 2009 through 2016. As we can observe tax fees paid only on the consolidated group level, we aggregate our digitalization index and obtain consolidated financial information from the ORBIS database. As above, we use the smallest value of an affiliate's digitalization index in a year as value for the overall group for this year. We code missing values in the Audit Analytics data as zero if we observe a non-missing entry in any other fees' category such as audit fees, audit-related fees or other fees.[28] The sample consists of 5,468 group-years, with 875 unique groups. These groups have a mean digitalization index value of 1.49 and 60 percent of the sample do not pay tax fees to the group's external auditor. For those that do, the mean tax fees paid amount to 245,686 euro.

We estimate the following equation:

$$log(TaxFees_{jt}) = \beta_1 Digital_{jt} + \beta_2 X_{jt} + \eta_t + \mu_{ind} + \varepsilon_{it}, \quad (7)$$

where the dependent variable is the natural logarithm of tax fees paid of group *j* in year *t*. Digital_{jt} is the digitalization index on group-level and the variable of interest. A negative estimate of β_1 provides empirical support for a positive relationship between a group's internal digitalization and tax fees paid. X_{jt} is a vector of group-specific control variables. We include the natural log of turnover, total assets and employee compensation from consolidated financial accounts. Further, we include profits and losses before taxes and productivity on the group level as well as the natural log of GDP per capita and the unemployment rate of group *j*'s home country. Finally, we include year fixed effects (η_t) and industry fixed effects (μ_{ind}) to control for time-varying changes and static industry characteristics. Standard errors are clustered by group to address serial correlation in within-group observations across the sample period.

[27] See Article 18 of Directive 2013/34/EU
[28] We manually inspect a randomized subsample to verify our approach.

We find a significant positive relation between digitalization and tax fees paid. Table 22 depicts the results. Using the digitalization index, we find that an increase by one index level leads, on average, to 47% higher tax fees paid.[29] When using the digitalization index as a categorical variable, we show in column two that firms that are digitalized pay, on average, significantly higher amounts of tax fees. Specifically, we see in column three that the difference in tax fees paid increases with higher categories of internal digitalization. These results are in line with our expectations and support our previous findings. Nevertheless, we acknowledge

Table 22: Analysis of additional compliance costs – tax fees analysis

	Dependent Variable: Log(Tax Fees)		
Variable	(1)	(2)	(4)
Digital	0.47***		
	(0.16)		
Digital = 1		0.40	0.79*
		(0.42)	(0.41)
Digital = 2		1.15**	
		(0.46)	
Digital = 3		1.21**	
		(0.52)	
PLBT	0.16	0.16	0.14
	(0.30)	(0.30)	(0.31)
Log(Tangible Assets)	0.93***	0.92***	0.94***
	(0.31)	(0.31)	(0.31)
Log(Employee Compensation)	-0.04	-0.03	-0.05
	(0.26)	(0.26)	(0.26)
Productivity	29.11***	28.86***	29.48***
	(7.47)	(7.48)	(7.46)
Log(GDP per Capita)	-0.21	-0.21	-0.24
	(0.24)	(0.24)	(0.24)
Log(GDP)	5.51***	5.49***	5.43***
	(0.48)	(0.48)	(0.48)
Unemployment	-0.03	-0.03	-0.03
	(0.05)	(0.05)	(0.05)
Year Fixed Effects	x	x	x
Industry Fixed Effects	x	x	x
Observations	4,978	4,978	4,978
Number of firms	833	833	833
R2 (within)	0.245	0.246	0.243

Notes: The dependent variable is the logarithm of tax fees. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

[29] We verify our results using a Poisson pseudo-maximum-likelihood specification (Silva and Tenreyro, 2006, 2011). This specification is used to deal with samples characterized by a large proportion of zero values of the dependent variable. Our untabulated result remains the same.

that our tax fees measure may underestimate the true amount of tax fees paid if firms will also take on non-auditor tax consulting services.

3.6.4. Changing the Digitalization Index

We replace the digitalization measure with a dummy variable that takes the value of one if the digitalization level is larger than zero. This variation of our digitalization index measure allows us to provide a clear-cut comparison between non-digitalized firms and firms that invest in digitalization. Columns one and two of Appendix 5 show that digitalized firms shift significantly more income. Further, we disentangle the different levels of our digitalization index more formally. In column three and four of Appendix 5, we interact each index level separately with the income shifting incentive measure. We find a negative interaction coefficient for all index levels. The inclusion of a categorical variable relaxes the functional form assumption and allows us to estimate the tax sensitivity of reported profits for each index level separately. We again find that the estimated tax sensitivity of reported profits is highest for firms with access to all three software solutions.

Next, we acknowledge that investment in digitalization might be a central decision of a multinational corporation's headquarter. Anecdotal evidence that relies on consultations with SAP sales people suggests that the deployment of digital technologies can differ greatly between firms that belong to the same multinational corporation. Practitioners in an IT department of a global multinational have reassured us that the rollout of digital technologies in separate firms of a multinational corporation is in general subject to local adjustments and the heterogeneous speed of adoption leads to different digitalization levels within a multinational corporation. Our granular data on digitalization is at the firm level and allows to precisely measure each firm's digitalization level. Nevertheless, we re-estimate our baseline approach including all affiliated firms of a multinational corporation to mitigate concerns that an extended sample leads to deviating results. We aggregate our digitalization index on the multinational corporation level and assign each firm of the multinational corporation the

average annually observed digitalization level. The results are depicted in Appendix 6. We still find that the level of digitalization is inversely related to the tax sensitivity of reported income, implying more tax-induced income shifting of firms with more digital technologies. The results hold if we disentangle the digital technologies that constitute our index.

3.6.5. Robustness Tests

In additional robustness tests, we use a non-interpolated digitalization index, include additional control variables, change our income shifting incentive measure and change the dependent variable.

First, the advantages of a high level of digitalization may be proportional to the complexity of a multinational corporation's structure. We proxy the complexity of a multinational corporation with its international dispersion, which we measure as the ratio of countries in which the multinational corporation has firms relative to the multinational corporation's total number of affiliated firms. Appendix 7 depicts the results. We provide evidence that the association between the income shifting incentive measure and digitalization is more relevant for internationally dispersed firms. I.e., the higher the international dispersion and the higher the degree of digitalization, the more negative is the association between reported income and the income shifting incentive measure (C) to relocate income from high- to low-tax jurisdictions.

Second, we replicate our main table with a non-interpolated digitalization index to control for any potential bias by our interpolation. The results are depicted in Appendix 8. Even if we include only firms for which we exactly know their survey response, all inferences remain as in our main results. Yet, we lose some observations, which lowers our statistical power.

Third, in Appendix 9, we include the logarithm of intangible assets as an additional control variable in our regression. Several studies show that intangible assets, patents or research and development activities provide an opportunity to relocate income (De Simone et al., 2016; Dischinger and Riedel, 2011). Intangible assets are, in general, difficult to value for

tax purposes and their relocation or extensive license payments provide a channel to shift profits. The first two columns of Appendix 9 show that keeping the level of intangibles constant, we still find a significant negative coefficient for the interaction of the income shifting incentive measure (*C*) and our digitalization index. This confirms our evidence that digitalized firms – independent of their use of intangible assets – tend to relocate income more than non-digitalized firms.

Fourth, we replace the income shifting incentive measure (*C*). The income shifting incentive measure (*C*), a weighted tax rate differential, can be affected by many different factors, e.g., tax rate changes or changes in affiliates turnover (De Simone et al., 2017). Hence, we use the corporate income tax rate as an easy to interpret income shifting incentive measure. Higher corporate income taxes should be associated with lower reported profits if the income shifting hypothesis holds. Indeed, our estimates in columns three and four of Appendix 9 indicate that non-digitalized firms do not seem to react to the CIT incentive. In contrast, firms with a digitalization index value of one or three do react.

Finally, we replace our dependent variable, the logarithm of PLBT, with the logarithm of earnings before interest and taxes. This measure neglects debt shifting as an income relocation channel. The results in columns five and six of Appendix 9 focus only on the transfer pricing income shifting channel and indicate that digitalized firms relocate income via transfer prices. However, our income shifting estimate is slightly smaller than in our main results, which implies that firms use both income-shifting channels.

3.7. Conclusion

Our study complements the understanding on the effects of digitalization on the performance of firms' tax functions by examining whether firms' investment in digitalization facilitates tax-induced income shifting. Existing studies provide first evidence on the association between better internal information environments and corporate tax avoidance (Gallemore and Labro, 2015; Hamilton and Stekelberg, 2016; McGuire et al., 2018). We validate and extend their

findings by examining the effects of digitalization on tax-induced income shifting along several dimensions. First, we use a measure of digitalization that goes beyond mere proxies of the degree of firm's internal information quality. Second, we disentangle the digital technologies in our dataset to uncover the channel that most likely enables tax strategies to shift income. Third, we apply the well-established Huizinga and Leaven (2008) approach to estimate tax-induced income shifting. Finally, we exploit a very granular and large dataset of European multinationals.

We create a novel micro-level digitalization index that captures firms' access to up to three key software solutions to digitally monitor and manage firm performance: Enterprise resource planning (ERP) software, database management systems (DBMS) and groupware software. This measure is matched to a rich set of financial data on European multinationals to evaluate our hypothesis.

Our hypothesis is based on the commonly accepted objective of firms to maximize after-tax returns. This involves effective tax planning decisions by the tax department to minimize the global tax burden. We hypothesize that firms with a higher level of digitalization engage more actively in tax-induced income shifting to increase profitability than firms with a low level of digitalization.

We find evidence on tax-induced income shifting only for digitalized firms. In contrast, non-digitalized firms do not seem to exploit their income shifting incentives efficiently. Further, we find that the presence of groupware software has the largest effect on tax-induced income shifting of European multinationals. Communication and coordination between different parts of a firm seems to be key enabler of multinational's tax planning strategies. Our inferences remain unaffected if we address potential endogeneity concerns by using an instrumental variables regression approach. We also find, as expected, that firms with a high level of internal digitalization promptly adjust reported profits upwards in jurisdictions with large negative shocks in the income shifting incentive measure (*C*). Finally, we demonstrate a significant

difference in the sensitivity of reported profits to the income shifting incentive measure (*C*) between firms after a change of the level of digitalization.

Overall, our results provide complementing evidence on the association between digitalization and decision making in a firm's tax departments. We find that digitalized firms make more efficient tax planning decisions in terms of income shifting. Our results imply that digitalization is a crucial foundation for timely, data-driven decision making that extends even beyond core business functions to support functions such as the tax department.

4. Investor Reactions to the CbCR Requirement for EU Financial Institutions[30]

4.1. Introduction

A couple of recent studies suggest that investors perceive a mandatory increase in tax transparency as a potent tool in curbing tax avoidance. More precisely, Johannesen and Larsen (2016), Chen (2017) and Hoopes et al. (2018) document negative stock price reactions around key dates of two legislative procedures that introduced new public tax disclosure obligations for certain companies. They interpret their findings as evidence of investors expecting the disclosure of new information to be costly for firms, mainly due to an anticipated increase in scrutiny by the public and by tax authorities, resulting in a potential reduction of profit shifting opportunities under the new disclosure rules. To provide a more general understanding of how tax reporting requirements – and in particular country-by-country reporting (CbCR) – are perceived by investors, we analyze the introduction of the public CbCR obligation for EU financial institutions, enacted in 2013.

Since the tax planning strategies of large multinational firms have moved into the focus of public and political attention, several EU and OECD initiatives have discussed potential measures to limit extensive profit shifting activities. One of these measures aims at improving tax transparency, in particular by mandating companies to disclose a CbCR, which contains certain tax-related information on a per-country basis. The data is supposed to help tax authorities in detecting abusive tax sheltering and – if it is made public – to exert public pressure on the firms inducing them to pay their "fair share of taxes" in the countries where they operate.

[30] This section is joint work with Verena K. Dutt, Katharina Nicolay, Heiko Vay and Johannes Voget. It has been published in *International Tax and Public Finance*, Vol. 26, Issue 6, December 2019, pp. 1259-1290. Copyright © 2019, Springer Science+Business Media, LLC, part of Springer Nature. The original publication is available at https://link.springer.com/article/10.1007/s10797-019-09575-4. We thank Leslie Robinson, Olli Ropponen (discussant), Martin Simmler (discussant), two anonymous referees and the participants of the International Institute of Public Finance (IIPF) Annual Congress 2018 in Tampere, the European Economic Association (EEA) Annual Congress 2018 in Cologne, the Annual Conference 2018 of the Verein für Socialpolitik (VfS) in Freiburg, and the Mannheim Taxation Science Campus Meeting 2017 in Mannheim for their helpful suggestions and comments. We gratefully acknowledge financial support from the Graduate School of Economic and Social Sciences of the University of Mannheim, from the Leibniz ScienceCampus MannheimTaxation and from the German Research Foundation (DFG, Project-ID 403041268 – TRR 266).

As one of the first CbCR initiatives, Article 89 of the Capital Requirements Directive IV (Directive 2013/36/EU, abbr.: CRD IV) requires EU financial institutions to publicly disclose reports for the financial year 2014 onwards.

In theory, several channels could drive investors' reaction to adopting this new rule. On the one hand, investors could appreciate the upcoming enhancement in tax transparency. The additional information may serve as a tool to better monitor the tax avoidance activities of managers and to limit their related possibilities to extract private benefits (Bennedsen and Zeume, 2018; Desai and Dharmapala, 2006; Desai et al., 2006). This potential decrease in information asymmetry could trigger a positive stock price response. On the other hand, investors might react negatively in anticipation of reduced future after-tax profits. As intended by the legislator, banks may cut back their tax planning to some extent due to increased scrutiny by the tax authorities and the general public (Dyreng et al., 2016; Graham et al., 2014). Besides, the new disclosure requirement might come along with substantial direct and implicit costs. (Graham et al., 2014; Hoopes et al., 2018)

Empirical evidence from similar settings indicates a negative response of the capital market. Hoopes et al. (2018) investigate a new public tax disclosure rule in Australia and document a significant stock price decline for all firms affected by the new rule, which is especially pronounced for firms expected to be disclosed as paying zero taxes. Chen (2017) extends their analysis to additional event dates in the legislative procedure. When accounting for the dividend imputation system in Australia and focusing on a portfolio of firms with clear incentives to minimize their corporate tax burden, Chen (2017) finds a negative and significant investor reaction aggregated over all event dates. Finally, Johannesen and Larsen (2016) exploit the introduction of the CbCR requirement for EU companies in the extractive industries through the EU Accounting Directive (Directive 2013/34/EU) and observe remarkable stock price declines of about 5-10%.

All these prior findings suggest that the channels of increased scrutiny by the tax authority and by the public dominate investors' perception of the introduction of tax disclosure requirements. Consequently, we also expect a negative reaction in our setting. Early empirical evidence (Joshi et al., 2020; Overesch and Wolff, 2019) indicating that banks changed their tax avoidance behavior to some extent after the implementation of the new CbCR requirement corroborates this expectation.

We employ an event study methodology to examine the capital market response around the day of the surprising political decision to include a CbCR obligation in the CRD IV proposal. We can reject a negative reaction larger than 2.1% and a positive reaction larger than 1.4% for the full sample of financial institutions headquartered in the EU. To investigate potential cross-sectional variation in the response to the new disclosure rule, we conduct several sample splits. As expected, we find that banks particularly exposed to the increase in tax transparency (proxied by tax haven usage) and banks more sensitive to reputational concerns (proxied by B2C orientation) exhibit a more negative reaction, while banks characterized by higher information asymmetry (i.e., a low share of institutional investors) show a more positive reaction. However, the effects measured for all subsamples are small in economic terms and statistically insignificant. Our results remain unchanged when considering two additional event dates and throughout various robustness checks.

We conclude that our cross-sectional tests provide some evidence of different channels driving the response to the CbCR introduction for EU financial institutions. The capital market may have perceived the new disclosure rule to result in a simultaneous decline in tax avoidance possibilities and a reduction in information asymmetry, implying both positive and negative stock price effects. This interpretation can explain why we do not observe a pronounced capital market reaction on average, while concurrent studies on banks' reaction to the CbCR requirement (Joshi et al., 2020; Overesch and Wolff, 2019) document that banks adjusted their tax avoidance behavior after the implementation of the rule.

We also relate our results to the findings of extant event studies investigating the introduction of similar tax transparency measures. Differences in research question and research design impede a direct comparison with Hoopes et al. (2018). However, the negative stock price reaction of Australian firms featuring tax avoidance incentives which are similar to those in our setting, as documented by Chen (2017), is small in economic terms and lies within the range of our confidence interval. In contrast, we can exclude the occurrence of a reaction as strong as the one observed by Johannesen and Larsen (2016) at the 5% level. While their setting shares several common features with ours, one important difference might explain the results. The reporting obligation in the extractive industries aims at preventing corruption by publishing payments to governments. By contrast, the objective in the banking sector is to increase transparency against the backdrop of the financial crisis and to reveal where profits are generated compared to where real economic activity occurs. These diverging objectives have translated into differences in the selection of items to be disclosed according to both rules. Consequently, the strong negative stock price reaction observed for the extractive industries might not be due to an anticipated reduction in tax avoidance. It may rather be dominated by investors' belief that this particular kind of CbCR disclosure effectively fights corruption and that companies have to increase their (legitimate) compensation to their host countries for extracted resources. This specific channel is not present in our setting of EU financial institutions.

We make several contributions to the growing literature on tax transparency. First, our paper sheds light on the impact and effectiveness of a particular tax transparency measure, namely CbCR. Up to now, most contributions on possible costs and benefits of the disclosure requirement have been normative (e.g., Cockfield and MacArthur, 2015; Evers et al., 2017). Empirical evidence on the impact of the CbCR for EU financial institutions on corporate tax avoidance is scarce and inconclusive. While Overesch and Wolff (2019) document a relative increase in the effective tax burdens of affected banks, Joshi et al. (2020) find a substitution of

profit shifting activities between different kinds of subsidiaries but no significant change at the corporate group level. We aim to complement this early research on the effectiveness of CbCR by investigating investors' perspective on this new transparency rule.

Second, our analysis provides evidence on the impact of tax transparency in general (not specifically CbCR) on the capital market. Several studies examine how investors value the publication of tax-related information about companies, focusing on the event of disclosure itself (Brooks et al., 2016; Chen, 2017; Gallemore et al., 2014; Hanlon and Slemrod, 2009; Hoopes et al., 2018; Huesecken et al., 2017; O'Donovan et al., 2019). However, little is known about how investors react to changes in rules that require the disclosure of additional information, i.e., an increase in tax transparency. Market responses to the actual disclosure of information reflect how specific publications of certain companies are perceived by the capital market. Focusing on legislative procedures on new disclosure requirements instead allows to assess how investors evaluate the new legislation as a whole and in particular its effectiveness.

While prior studies and our cross-sectional tests are generally in line with increased tax transparency curbing tax avoidance of multinational companies, our results also suggest that the very strong capital market reaction to the CbCR introduction for the EU extractive industries was rather due to its effectiveness in fighting corruption. This inference is of special importance in light of the ongoing discussion about whether to adopt a public CbCR requirement for all EU-based multinational firms with profits above a certain threshold (European Commission, 2016; European Parliament, 2017, 2019b). Compared to the CbCR for EU financial institutions, the current proposal for a general public CbCR (European Parliament, 2019b) provides for a more salient way of disclosure and a more comprehensive list of items, which could further increase the effectiveness of the CbCR in preventing tax avoidance and thereby affect the perception of the disclosure requirement by investors.

The remainder of this paper is structured as follows: Section 4.2 provides information on the CbCR requirement for EU financial institutions, the legislation procedure, and prior

literature related to our study. Section 4.3 describes the data and the research design. Section 4.4 presents the results of our analysis which are complemented by robustness checks and further analyses in section 4.5. Section 4.6 concludes.

4.2. Background and Hypotheses

4.2.1. The CbCR Requirement for EU Financial Institutions

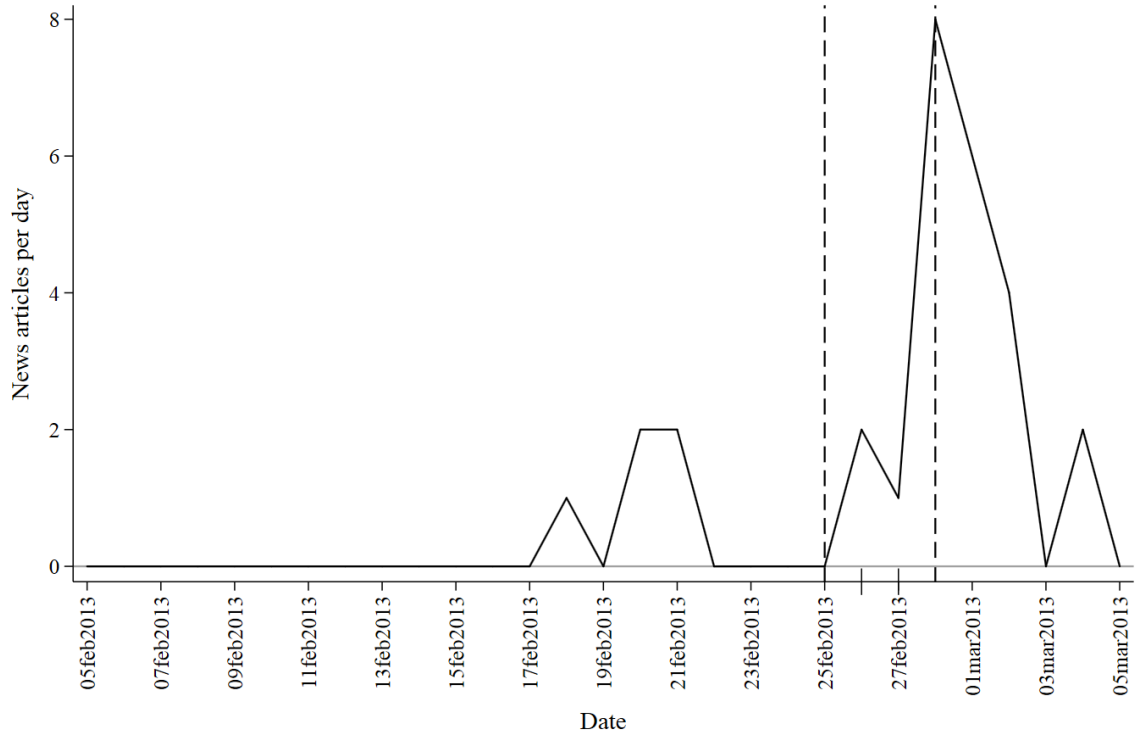
The political intention to oblige EU financial institutions to publicly disclose CbCR information emerged quite as a surprise on 27 February 2013, which marks the key event date of our study. In a trilogue between the Presidency of the European Council, the European Parliament and the European Commission on this day, it was decided to incorporate this new reporting obligation in the CRD IV. The main purpose of the CRD IV and the accompanying Capital Requirements Regulation (Regulation EU No 575/2013, abbr.: CRR) was to implement the Basel III standards into EU law, including i.a. capital, liquidity and leverage requirements and new provisions regarding corporate governance and remuneration. While the legislative procedure had already started in 2011 (European Commission, 2011) and most key features had been publicly debated, the idea of a CbCR obligation did not appear in any of the proposals or public discussions before the trilogue. It was only a spontaneous initiative of some members of the European Parliament which triggered this mandatory increase in tax transparency. Parliamentarians argued that, given the central role of banks and the large amount of public subsidies they have received during the financial crisis, EU citizens should be able to assess whether they are paying their "fair share of taxes" in the countries where they operate. Due to the unpredicted nature of the decision in the trilogue on 27 February 2013, we expect to observe an investor reaction around this date.

On 26 June 2013, the CRD IV was finally signed by the president of the European Parliament and the president of the European Council. The CbCR rule contained in Article 89 requires EU credit institutions and investment firms to publicly disclose turnover, the number of employees, profit or loss before tax, tax on profit or loss, and public subsidies received on a

per-country basis as well as the name, location and nature of activities of their subsidiaries and branches. The disclosure obligation applies to financial years 2014 onwards. Groups headquartered in the EU have to provide a CbCR with respect to the whole group, whereas groups headquartered outside the EU only have to disclose information for their EU entities, including their subsidiaries and branches.

To further examine whether the trilogue decision to include a CbCR obligation was unexpected, we analyze the media coverage of the topic around our event date. Following Hillert et al. (2014) and Chen et al. (2019), we conduct searches in the Factiva and Lexis Nexis databases for news articles addressing the (potential) CbCR introduction for EU financial institutions. The number of relevant articles on each date is depicted in Figure 15. The figure

Figure 15: Trend analysis for news reports on CbCR around the event window



Notes: The figure depicts the number of relevant articles on CbCR for each date. We conduct our searches in the Factiva and the Lexis Nexis database for the period 5 February to 5 March 2013 using the following search terms: country-by-country reporting or country-by-country report or cbcr or capital requirements directive or crd iv. After eliminating duplicates (i.e., identical articles contained in both databases), we read through all search results in English language to identify articles that actually address the (potential) CbCR introduction for EU financial institutions by the CRD IV. The dashed lines frame the dates around the event date (25/02/2013 to 28/02/2013). The crossing x-axis marks represent the consecutive days within this window.

exhibits a sharp increase directly after the event on 27 February 2013 reflecting that the inclusion of CbCR in the EU directive appears to have come unexpected.

In addition, on 26 February 2013, the non-governmental organization "Avaaz" launched a petition requesting the inclusion of a CbCR requirement in the CRD IV. They managed to get more than 200,000 signatures until 27 February 2013, among them members of the European Parliament supporting CbCR (The Guardian, 2013b). This event underlines the sudden increase in public interest in a CbCR requirement for the banking sector.

Other topics discussed in the trilogue concern additional capital buffer requirements for systemically important institutions, the flexibility for Member States to take country-specific prudential measures, the power of the European Banking Authority to mediate on its own initiative in the event of conflicts between national competent authorities, and details of and exemptions from the bonus cap for banks' managers. News articles around the trilogue, though, show that the CbCR requirement and the bonus cap for managers are the only two topics that received substantial public attention. While the 1:1 ratio of the bonus cap has already been agreed upon on 19 February 2013 and only been specified in the trilogue on 27 February 2013 in more detail, the inclusion of CbCR was completely open until then.

Furthermore, at the date of the trilogue, no other legal initiatives existed on a general CbCR or a CbCR for the financial sector. The confidential CbCR for large multinational firms proposed by the OECD (OECD, 2015c) dates back to the OECD's initiative against Base Erosion and Profit Shifting (OECD, 2013b). Though, in February 2013, the concept of a CbCR had not yet been elaborated. In its report "Addressing Base Erosion and Profit Shifting" published on 12 February 2013, the OECD only expresses the "need for increased transparency on effective tax rates of MNEs" (OECD, 2013a, p. 6). Thus, we are confident that our event date is characterized by a strong increase in the likelihood of the introduction of a public CbCR for EU financial institutions.

4.2.2. Prior Literature and Hypotheses

The CbCR introduction for EU financial institutions constitutes an increase in the volume of publicly available tax-related information. To assess the consequences for the future profits of the companies affected, investors have to predict how managers, the tax authorities, consumers and the public sentiment will react to the new disclosure requirement. From a theoretical point of view, different channels could drive the response of the capital market.

On the one hand, investors might predict a reduction of the costs of capital for the affected banks. The capital market might appreciate the upcoming increase in transparency as the CbCRs could provide more certainty regarding banks' tax positions as well as additional information on the geographical distribution of activities and earnings. Ultimately, this data can help to increase the accuracy of analysts' forecasts. Prior evidence suggests that tax-related information can be useful in forecasting future earnings (Bratten et al., 2016; Demere, 2018; Hanlon et al., 2005). Moreover, the CbCR information might serve as a tool for investors to better monitor managers' tax planning activities. Engaging in tax sheltering does not only allow firms to save taxes, which is in the interest of all shareholders, but can also be exploited by managers and controlling shareholders to divert rents to their own advantage. As Desai and Dharmapala (2006) have found, tax avoidance and the extraction of private benefits by managers are complementary. In the same vein, Desai et al. (2007) have documented that an enhancement in tax enforcement reduces managers' possibilities of rent extraction. Bennedsen and Zeume (2018) provide evidence that an increase in transparency through the signing of tax information exchange agreements (TIEA) between home countries and tax havens increases the cost for managers to engage in expropriation of minority shareholders through the use of tax havens. This positive effect of TIEAs on firm value from reducing the self-serving activities of managers outweighs the negative effect from declining opportunities for pure tax saving via tax havens. In the same vein, the new CbCR requirement might decrease the information asymmetry between managers and shareholders. The information to be disclosed makes the tax

avoidance activities of firms more transparent to shareholders, which might impede private rent extraction by managers. As a consequence, the capital market may react positively to the introduction of the new disclosure obligation.

On the other hand, investors could expect a decrease of banks' future profits. First, banks might reduce their extent of profit shifting since tax authorities have more information at hand to audit tax-aggressive banks more efficiently.[31] As Bozanic et al. (2017) have shown, tax authorities actually make use of tax-related disclosures in financial statements in case they contain incremental information to the tax return data. Second, increased public scrutiny might induce banks to voluntarily pay their "fair share of taxes". Several studies have documented that companies adjust their tax planning activities due to reputational concerns (C. R. Austin and Wilson, 2017; Dyreng et al., 2016; Graham et al., 2014; Hoopes et al., 2018). Finally, investors might also expect the new disclosure rule to impose additional costs on the companies. Apart from direct costs for an initial adjustment of the reporting system and for the annual compilation of the reports, companies may also face considerable indirect costs in the form of reputational damages from being potentially blamed for aggressive tax planning (Evers et al., 2017).

In summary, there are three potential channels which could drive the response of investors to the new disclosure rule: (1) reduction in information asymmetry, (2) tax authority scrutiny and (3) public scrutiny. While the first channel should result in a relative stock price increase of the affected firms, the latter two channels would lead to a relative decrease. Thus, it remains an empirical question how the capital market actually reacted to the introduction of the CbCR obligation.

Due to the recent nature of the rule, empirical evidence on whether EU financial institutions changed their behavior in response to the CbCR introduction is scarce and

[31] Tax authority scrutiny should only matter if the tax authority's prior information set is inferior to the new set after the disclosure requirement is implemented.

preliminary. Two early studies investigate potential behavioral responses with regard to the extent of tax planning activities. Overesch and Wolff (2019) find that European multinational banks reduced their tax avoidance after the implementation of the new disclosure obligation. They document an increase in the effective tax burdens of European-headquartered multinational banks relative to different control groups unaffected by the CbCR requirement. The reaction is especially pronounced for banks with activities in tax havens due to their higher exposure to the increased transparency. In contrast, Joshi et al. (2020) do not find a significant decline in the tax avoidance behavior at the corporate group level, measured by the effective tax rate. They claim that banks are able to substitute profit shifting activities between subsidiaries subject to different degrees of transparency, which leaves the overall level of tax avoidance unaffected. In particular, they document decreases in profit shifting through financial affiliates and increases in profit shifting through industrial affiliates, the latter of which they consider not to be included in the scope of the CRD IV.

While Overesch and Wolff (2019) and Joshi et al. (2020) shed some light on the tax avoidance behavior of banks affected by Article 89 of the CRD IV, their findings are – at least partly – contradictory. Moreover, as shown above, the capital market might not only reflect the implications of more tax transparency for tax avoidance, but might also incorporate additional channels in its reaction. Thus, it still remains an open question how investors have assessed the consequences of the upcoming increase in tax transparency.

Three recent event studies examine the stock price reaction in similar settings. Hoopes et al. (2018) and Chen (2017) both exploit a new rule in Australia, issued in 2013. It requires the Australian Taxation Office to publicly disclose certain items from corporate tax returns (i.a. taxable income and income tax payable) of large private and public companies. Hoopes et al. (2018) focus on a major date in the legislative procedure when the details of the intended rule, including the disclosure threshold and the tax return items to be reported, were announced for the first time. They find a negative capital market reaction for all firms affected by the new rule,

whereby stock prices of firms expected to be disclosed as paying zero taxes experienced a significantly stronger decline.

Chen (2017) extends their analysis by three additional decisive dates in the legislative procedure that revealed new information and/or increased the probability of the passage of the law. While she also observes a significant (albeit considerably smaller) stock price decline on the event date shared with Hoopes et al. (2018), she documents an overall positive reaction across all four event dates. She concludes that investors adjusted their perception of the new rule in the course of the legislative procedure and that they ultimately anticipated a net benefit of disclosure. Nevertheless, Chen (2017) also takes note of the particularity of the dividend imputation system applicable in Australia. Individual shareholders resident in Australia who receive dividends from Australian corporations can generally credit the corporate tax payment of the corporation against their personal income tax liability. Thus, in contrast to the classical or shareholder relief systems prevailing in most developed countries, resident individual shareholders in Australia should not be as concerned about corporate tax minimization as foreign shareholders. Chen (2017) addresses this difference in corporate tax avoidance incentives in a cross-sectional test. She finds that corporations characterized by a relatively high fraction of foreign shareholders not benefitting from the imputation tax credit exhibit a small but significant negative stock price reaction overall. For this subgroup of firms facing tax avoidance incentives which should be more comparable to our European setting, the market apparently anticipates the costs of disclosure to outweigh the benefits.

Johannesen and Larsen (2016) analyze the capital market response around four key dates in the legislation process of the EU Accounting Directive (Directive 2013/34/EU), which introduced a CbCR requirement for EU companies in the extractive industries. They find significant decreases in firm value around two of their event dates, with a remarkable overall effect amounting to 5-10%. They interpret their result as evidence of tax planning creating additional profits for the firms considered and of financial transparency being a potentially

powerful tool to restrict this behavior. Due to the common features of the settings, their study is closely related to ours. Both the Accounting Directive and the CRD IV are EU Directives which mandate companies of a specific industry to publicly disclose a CbCR. They mainly differ insofar as the CRD IV applies to the financial sector whereas Chapter 10 of the Accounting Directive targets companies active in the extractive industries. However, recent findings by Merz and Overesch (2016) and Langenmayr and Reiter (2017) confirm that banks also engage in tax avoidance and that they exhibit an even higher tax sensitivity compared to other industries.[32] Thus, it is reasonable to assume that additional disclosures revealing tax planning activities are not less relevant for banks than for natural resource companies.

Taking together the findings of Hoopes et al. (2018), Chen (2017) and Johannesen and Larsen (2016), we expect to observe a negative capital market reaction also in the setting of the CbCR introduction for EU financial institutions.

4.3. Data and Methodology

We employ an event study methodology as laid out by Kothari and Warner (2007) and applied by Johannesen and Larsen (2016) to estimate the impact of the CbCR introduction on the stock returns of the institutions affected. In particular, we investigate whether the capital market reacted to the proposed introduction of the new disclosure regulation around our key event date, 27 February 2013. As commonly used in the literature, our event window covers three trading days centered on the event day, i.e., the period 26-28 February 2013 (D. H. Austin, 1993; Eckbo et al., 2007). Due to the generally quick dissemination of information, we expect to observe a market reaction on the next trading day after the news at the latest. Furthermore, the inclusion of 28 February 2013 accounts for the peak in news articles on CbCR following the trilogue meeting (see section 4.2.1). The inclusion of one day prior to the event allows to capture any

[32] These studies document a tax semi-elasticity of banks' overall reported profits of about 2.4 (Merz and Overesch, 2016) and of certain trading gains of about 3.4 to 4.0 (Langenmayr and Reiter, 2017; Merz and Overesch, 2016). This effect is quite large compared to the consensus estimate by Heckemeyer and Overesch (2017) of 0.8.

potential effect of information available to the market before the event. It also enables us to take into consideration the starting date of the Avaaz petition for a CbCR requirement.

For our main specification, we use ownership information provided by the Orbis Bank Focus database to construct a sample of listed entities of bank groups whose global ultimate owner is located in the EU. I.e., the listed entity can either be a subsidiary of such a bank group or the global ultimate owner itself. For these banks, the CbCR requirement should be of highest relevance since the report must be provided by the global ultimate owner for the whole group, hence revealing all profit shifting opportunities of the group. We limit our sample to banks where at least one shareholder, subsidiary or branch is located in a different country than the bank itself. The underlying reason is that a purely domestic group has no possibility and incentive to shift profits cross-border, and therefore the CbCR does not provide any incremental information on the appropriateness of taxes paid in light of the economic activity.

We merge the ownership information with daily stock prices from Datastream/Eikon for the period from January 2012 to December 2014. Banks with insufficient price information and banks with constant zero returns over time are dropped.[33] To avoid possible distortions by confounding events, we also exclude banks located in countries where a major election took place as well as banks explicitly targeted by major ECB announcements within one week before or after the event date.[34] Our final main sample includes 155 listed banks. Table 23 shows descriptive statistics for the treatment group and the control group. The sample mean of the stock returns is 0.070% with a standard deviation of 0.706. Table 24 shows the distribution of the treated banks over countries and Appendix 10 provides the corresponding information for the control group.

[33] In particular, we require the price information to be available for at least 80% of the trading days in the event and pre-event period to estimate the expected returns. We keep only banks with a non-zero return in more than 30% of the estimation and event period to capture those firms that are actively traded and thus do not have constant zero returns over time. The sample is very insensitive to any variation of these thresholds.

[34] Due to this restriction, we have to drop one bank located in Cyprus and 21 banks located in Italy.

Table 23: Descriptive statistics of daily stock returns for different groups of banks

Realized return	N	Mean	Standard deviation	1st percentile	99th percentile
Treated banks	155	0.070	0.706	-1.755	1.929
Control group	537	0.072	0.437	-1.172	1.134

Notes: Treated banks are entities of bank groups whose global ultimate owner is located in the EU. Banks in the control group are entities of bank groups whose global ultimate owner is located outside the EU. The descriptive statistics are calculated for the period from 1 January 2012 to 31 December 2014. All values, except for the number of banks N, are stated in percent.

For each treated bank i, we calculate the daily abnormal return $AR_{i,t}$ as the difference between the actual realized return $R_{i,t}^{act}$ and the expected return $R_{i,t}^{exp}$ on trading day t.

$$AR_{i,t} = R_{i,t}^{act} - R_{i,t}^{exp} \tag{8}$$

We use different approaches for calculating the expected return. First, we estimate the market model for a time horizon of one year, ending six days before the event, where $R_{i,t}^{act}$ denotes the actual firm return, $R_{m,t}$ denotes the market return, and $\varepsilon_{i,t}$ is a zero mean disturbance term (MacKinlay, 1997).

$$R_{i,t}^{act} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \tag{9}$$

We consider two different market indices, namely S&P Global 1200 (following Johannesen and Larsen, 2016) and MSCI World Banks. While S&P Global 1200 proxies the market portfolio, MSCI World Banks is better tailored to the banking sector, hence absorbing industry specific shocks. The estimated coefficients are then applied to the market return on each day of the event period to compute the expected returns for each firm and day. One caveat of the market model event study method is that treated firms may be constituents of the index used for calculating expected returns, which tends to attenuate the estimates of abnormal returns. The treated firms in our sample represent up to 3.86% of the S&P Global 1200 index

Table 24: Dispersion of treated banks over countries

Country	Banks		Percent	Country	Banks		Percent
	Number	Thereof parents			Number	Thereof parents	
Argentina	2	0	1.29	Kenya	2	0	1.29
Austria	5	5	3.23	Luxembourg	1	1	0.65
Belgium	3	2	1.94	Malta	2	1	1.29
Brazil	1	0	0.65	Mexico	1	1	0.65
Bulgaria	1	1	0.65	Morocco	1	0	0.65
Canada	1	0	0.65	Netherlands	6	5	3.87
Chile	1	0	0.65	Pakistan	2	0	1.29
Croatia	2	0	1.29	Poland	9	2	5.81
Czech	1	0	0.65	Portugal	2	1	1.29
Côte d'Ivoire	1	0	0.65	Romania	2	1	1.29
Denmark	9	9	5.81	Russian Federation	2	1	1.29
Finland	5	4	3.23	Slovakia	1	0	0.65
France	14	9	9.03	South Africa	3	1	1.94
Germany	14	10	9.03	Spain	9	8	5.81
Ghana	1	0	0.65	Sweden	6	6	3.87
Greece	6	6	3.87	Switzerland	2	0	1.29
Hong Kong	1	0	0.65	Tunisia	2	0	1.29
Hungary	2	2	1.29	United Kingdom	30	27	19.35
Ireland	1	1	0.65	Venezuela	1	0	0.65
				Total	**155**	**104**	**100.00**

Notes: Treated banks are stock-listed entities of bank groups whose global ultimate owner is located in the EU. These groups are obliged to issue a CbCR for the whole group, revealing all tax haven subsidiaries and branches. Consequently, all affiliates of these groups are fully affected by the CbCR introduction. As some bank groups whose global ultimate owner is located in the EU also have stock-listed subsidiaries in non-EU countries, the sample of treated banks also contains a few banks entities located in non-EU countries. In total, we have 155 treated banks in our main sample. The depicted countries reflect the residence of the listed bank entities, which corresponds to the place of stock issuance. In general, the shares of listed banks are traded in the local currency of their home country, except for the shares of the one bank located in Luxembourg (traded in USD), one bank in Malta (traded in ZAR) and one bank in Sweden (traded in EUR). The column "Banks – Thereof parents" depicts the number of banks in a country that are global ultimate owners (N=104).

and up to 32.01% of the MSCI World Banks index.[35] As an alternative, we construct a control group of banks not directly affected by the CbCR requirement, i.e., entities of bank groups whose global ultimate owner is located in a non-EU country.[36] The daily expected returns – which under this alternative are identical across the treatment firms – equal the average realized returns of the control group firms on the respective days. Figure 16 illustrates the average

[35] Alternatively, we also computed expected returns based on the Stoxx Europe 600 Ex Financials index, which excludes financial firms. The untabulated estimates are very similar to the case when using the S&P Global 1200 index as the benchmark.

[36] Strictly speaking, the control group banks may also fall under the scope of Article 89 CRD IV if they have subsidiaries and/or branches in EU countries. Still, in this case, the report covers only the EU entities and their subsidiaries and branches, thus revealing only part of the group structure. This allows groups to structure their operations in such a way that tax haven operations are not evident from the CbCRs of their EU entities. We therefore assume no (or at least a considerably smaller) investor reaction for our control group banks. Besides, we address the issue of the (perceived) scope of the CbCR regulation in the robustness tests in Section 4.5.2.

abnormal returns for a period of three weeks prior to our event window, using the different control indices and the control group. The small variation around zero indicates comparable pre-trends for all our specifications.

For each abnormal return specification and firm, we then compute the cumulative abnormal return CAR_i over the three-day event window.

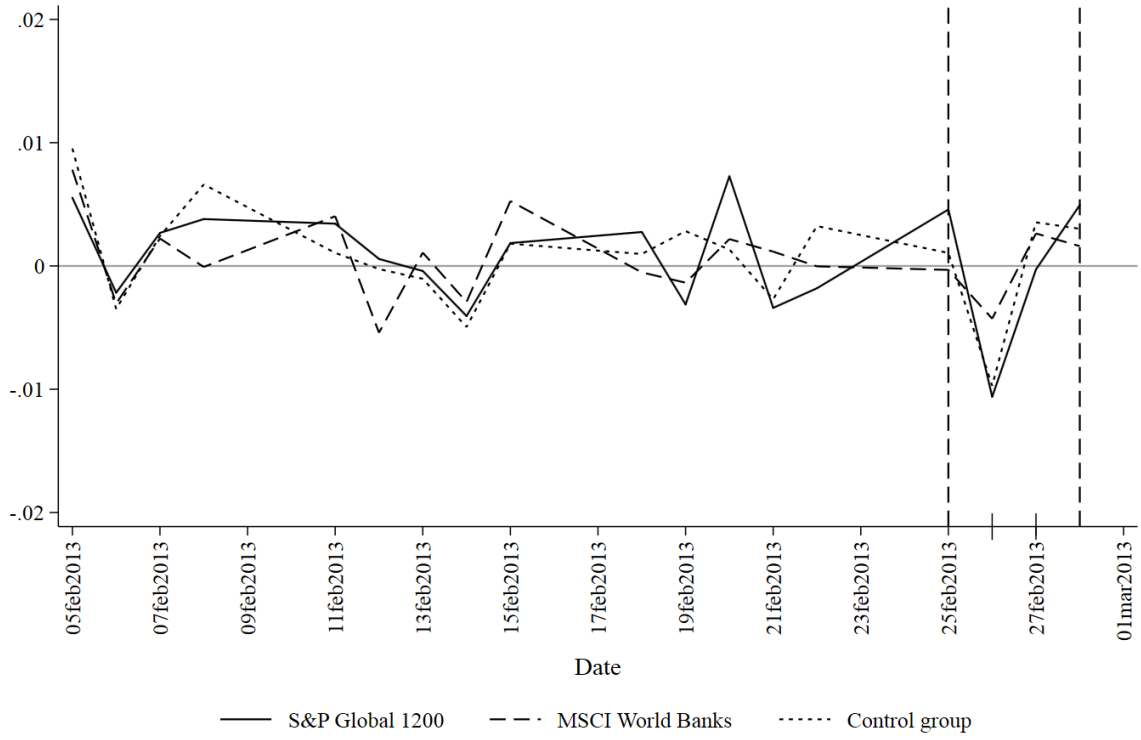
$$CAR_i = \sum_{t=1}^{T} AR_{i,t} \tag{10}$$

Finally, we calculate the cumulative average abnormal return $CAAR$ by taking the average of the cumulative abnormal returns across all firms.

$$CAAR = \frac{1}{N} \sum_{i=1}^{N} CAR_i \tag{11}$$

In order to test the statistical significance of the $CAARs$, we employ a t-test which is constructed as the ratio of the event $CAAR$ and the standard deviation of the pre-event $CAARs$.

Figure 16: Average abnormal returns three weeks prior to and within the event window



Notes: The lines indicate the average abnormal returns (in decimal) for all three specifications ($\frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$), where N is the number of banks in the treatment group. The dashed vertical lines frame the dates around the event date (25/02/2013 to 28/02/2013). The crossing marks on the x-axis represent the consecutive days within this window. The small variation around zero indicates comparable pre-trends for all three specifications.

The latter are defined as the $CAARs$ for each three-day window in the pre-event period (similar to Johannesen and Larsen, 2016). In the absence of abnormal returns, the test statistic is typically assumed to follow a unit normal distribution (Kothari and Warner, 2007).

4.4. Results

4.4.1. Baseline Results

Table 25 presents the results of our baseline model. Around the key event date, 27 February 2013, all specifications yield negative cumulative average abnormal returns for the treatment group of banks headquartered in the EU. However, the returns are small in size (between 0.0% and 0.6%) and insignificant throughout all three specifications.[37] This outcome does not provide any statistical evidence of an investor reaction to the proposed disclosure obligation that is different from zero. Instead, the confidence intervals of our three main specifications indicate that the stock market did neither show a negative reaction larger than 2.1% nor a positive reaction larger than 1.4%.

As described above, the trilogue on 27 February 2013 marks the date of the first political agreement requiring EU financial institutions to publish Country-by-Country reports. Since the previous drafts of the CRD IV and CRR did not contain such a rule, it is reasonable to assume that the decision of the co-legislators during the trilogue contains a surprise component for investors. However, the lack of a significant reaction could possibly be due to information being

Table 25: Cumulative average abnormal returns – three-day window

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
26-28 Feb 2013	-0.006 (-0.777) [-0.021, 0.009]	-0.000 (-0.005) [-0.012, 0.012]	-0.003 (-0.354) [-0.021, 0.014]

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The 155 treated banks are entities of bank groups whose global ultimate owner is located in the EU. t-test statistic in parenthesis and 95% confidence interval in square brackets. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

[37] The results based on the Stoxx Europe 600 Ex Financials index yield a negative cumulative average abnormal return of 0.5% with a t-statistic of -0.613. The results are in general similar to the ones when using the S&P Global 1200 index throughout all further specifications.

disseminated to the market shortly before the event window. On 25 February 2013, three members of the European Parliament (so-called "shadow rapporteurs") collectively signed an open letter to all ECOFIN ministers calling for support for their initiative to implement a CbCR obligation in the CRD IV (European Parliament, 2013). It is possible that this incident already raised investors' expectations of the new disclosure rule and that, consequently, stock prices reacted immediately. To address this concern, the daily abnormal returns from 25 to 28 February 2013 are depicted in Table 26 and graphically illustrated in Figure 16. We do not find any evidence of a stock price reaction on the day of the open letter, 25 February 2013. What we do observe is a relative stock price decline on 26 February 2013 ranging from 0.4% to 1.1%, which is significant (marginally significant) in the specification based on the S&P Global 1200 index (based on the control group). However, since 26 February 2013 is already included in our event window, the decline is neither strong enough nor persistent enough to appear as significant in a three-day window. Thus, the publication of the open letter does not invalidate our choice of the event window.

In addition, we also take account of the concern that the inconclusive result of the Italian general election on 26 February 2013 might influence our results as such an outcome was perceived to be a "turn for the worse" (Financial Times, 2013). Italian banks are already

Table 26: Daily average abnormal returns – around event date

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
25 Feb 2013	0.005	-0.000	0.001
	(0.961)	(-0.083)	(0.195)
26 Feb 2013	-0.011**	-0.004	-0.010*
	(-2.226)	(-1.127)	(-1.788)
27 Feb 2013	-0.000	0.003	0.004
	(-0.059)	(0.695)	(0.651)
28 Feb 2013	0.005	0.002	0.003
	(1.035)	(0.425)	(0.556)

Notes: The table displays daily average abnormal returns. The 155 treated banks are entities of bank groups whose global ultimate owner is located in the EU.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

excluded due to our sample selection criteria (see section 4.3). However, it is still possible that the stock prices of other European banks were also negatively affected due to relatively more exposure to the Italian market, which would introduce a downward bias. To address this issue, we rerun our analysis separately with two modified samples. First, we relax our sample restrictions and do not drop observations due to the occurrence of elections or ECB announcements. This relaxation is largely equivalent to extending the sample by banks located in Italy, which should be affected the most by the election outcome. Second, we use a more restrictive sample and exclude banks located in countries in which the financial sector is reported to have a substantial exposure to Italian sovereign debt.[38]

The daily stock returns and the returns for the three-day event window for both modified samples are depicted in Table 27. When we include Italian banks, the negative return on 26 February 2013 becomes larger in size and stronger in terms of significance, indicating that stock prices of Italian banks were indeed negatively affected by the election. However, the reaction is still insignificant in the conventional three-day event window. Conversely, excluding also non-Italian banks with a high exposure to the Italian market leads to results which are very similar to the ones obtained in our main sample.

These findings mitigate the concern regarding the impact of the Italian election. In any case, a potentially remaining negative bias despite the exclusion of Italian banks from the benchmark sample would change the interpretation of our estimates to a lower bound for the actual effect, i.e., firm values reacted more positively to the disclosure requirement than implied by our estimates.[39]

[38] In response to the financial crisis 2008, the European Banking Authority has analyzed the exposure of banks to sovereign debt. We use this data, provided by The Guardian Data Blog (2013), to examine the country-specific average exposure of banks to Italian sovereign debt and exclude all jurisdictions in which the exposure to Italy exceeds 10% of the gross exposure to government debt. The results are robust to lowering this threshold.

[39] Alternatively, if the effects of the two events are concentrated on the day at which they take place, then they are separable by analyzing the daily average abnormal returns in Table 26 and Panel A and B of Table 27.

Table 27: Average abnormal returns – alternative sample specifications

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Panel A: Daily average abnormal returns relaxing the sample restrictions – around event date			
25 Feb 2013	0.006	0.000	0.001
	(1.047)	(0.035)	(0.213)
26 Feb 2013	-0.015***	-0.008**	-0.015**
	(-2.858)	(-1.972)	(-2.361)
27 Feb 2013	-0.001	0.002	0.004
	(-0.135)	(0.605)	(0.615)
28 Feb 2013	0.003	-0.001	0.001
	(0.599)	(-0.143)	(0.233)
Panel B: Daily average abnormal returns with additional sample restrictions – around event date			
25 Feb 2013	0.004	-0.001	0.001
	(0.865)	(-0.155)	(0.142)
26 Feb 2013	-0.010**	-0.004	-0.009
	(-2.039)	(-0.934)	(-1.634)
27 Feb 2013	0.000	0.003	0.004
	(0.027)	(0.761)	(0.700)
28 Feb 2013	0.006	0.002	0.004
	(1.164)	(0.606)	(0.677)
Panel C: Cumulative average abnormal returns relaxing the sample restrictions – three-day window centered on event date			
26-28 Feb 2013	-0.013	-0.006	-0.010
	(-1.448)	(-0.903)	(-0.907)
Panel D: Cumulative average abnormal returns with additional sample restrictions – three-day window centered on event date			
26-28 Feb 2013	-0.004	0.002	-0.001
	(-0.529)	(0.260)	(-0.157)

Notes: Panel A displays the daily average abnormal returns around the event date after relaxing the sample restrictions as described in Section 4.3. The resulting sample without these adjustments still includes Italian and Cypriot banks in the treatment group (N=177). Panel B displays the daily average abnormal returns around the event date with additional sample restrictions: Countries with banks that have on average above 10% exposure to Italian sovereign debt (in relation to banks' gross exposure to government debt) are excluded from the treatment group (N=139). The exposure of banks to Italian sovereign debt is based on data by the European Banking Authority that depicts the share of exposure to government debt (the data is provided by The Guardian Data Blog 2013). For completeness and comparability to our main specification, we additionally provide estimates for a three-day window centered on the event date for both alternative samples. Panel C displays the cumulative average abnormal returns for a three-day window centered on the event date after relaxing the sample restrictions (N=177). Panel D displays the cumulative average abnormal returns for a three-day window centered on the event date for treated banks with a low exposure to Italian sovereign debt (N=139).
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

In summary, contrary to the expectations derived from the findings by Johannesen and Larsen (2016), Chen (2017) and Hoopes et al. (2018), our results suggest a zero capital market response to the proposed increase in tax transparency for EU financial institutions. More precisely, we can reject that the negative effect of the public CbCR introduction on the stock prices of affected banks was larger than 2.1%.

4.4.2. Cross-Sectional Analysis of Different Channels at Work

As theory provides arguments for both positive and negative investor reactions to additional tax disclosure requirements, the absence of an economically meaningful effect on average in the whole sample might be due to the concurrence of both reactions for different kinds of banks cancelling each other out. For example, investors may predict a stronger decrease in after-tax earnings due to reduced profit shifting opportunities and additional costs for certain banks, while for other banks, they may place more weight on the expected benefits from reduced information asymmetry. In this vein, Chen (2017) and Hoopes et al. (2018) provide some evidence on heterogeneity in the capital market response in the Australian setting.

To examine potential cross-sectional variation in the sample of EU financial institutions, we conduct four sample splits. First, consistent with Hoopes et al. (2018)[40], banks that are perceived to engage strongly in tax planning would need to reduce their tax planning activities to a higher extent or should suffer more reputational costs due to enhanced transparency than banks that are assumed to pay their "fair share of taxes". We calculate the effective tax rate (ETR) for each bank based on the consolidated financial statements and use the median ETR to partition our sample into banks with a high vs. a low level of (assumed) tax avoidance. Table 28 shows the cumulative average abnormal returns for the three-day window, separately for high and low ETR banks. Surprisingly, the abnormal returns are even slightly positive for the

[40] For her sample split based on tax avoidance incentives, Chen (2017) exploits particularities of the Australian imputation system under which domestic shareholders receive credits for the corporate tax paid by the firm. This identification approach is not suitable in the European Union setting because the countries in our sample generally do not discriminate between domestic and foreign shareholders due to EU regulation.

subsample of low ETR banks and negative for the subsample of high ETR banks, albeit none of the coefficients are significant.

However, it has to be noted that annual ETRs can be quite volatile and that a low ETR can result from several other reasons than tax planning. For instance, a low ETR might also follow from the existence of high tax loss carry-forwards that are offset against future profits. In this case, the ETR does not adequately reflect the level of tax avoidance. In order to proxy for the extent of tax avoidance via cross-border profit shifting more explicitly, we conduct a sample split that accounts for banks' presence in tax havens. Banks' activities in tax havens are directly revealed in the CbCRs. Hence, banks with subsidiaries and/or branches in tax havens should be more in the focus of the public and of tax authorities after the introduction of the CbCR requirement than banks without any presence in these locations. Therefore, following Overesch and Wolff (2019), we consider bank groups engaging in at least one of five selected European tax havens (namely Cyprus, Ireland, Liechtenstein, Luxembourg and Malta) to be

Table 28: ETR sample split

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with ETR below median ETR in the EU			
26-28 Feb 2013	0.005	0.010	0.004
	(0.428)	(0.863)	(0.296)
Banks with ETR above median ETR in the EU			
26-28 Feb 2013	-0.012	-0.005	-0.007
	(-1.175)	(-0.607)	(-0.549)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. We use the 2011 financial statements to calculate the ETR for our event as investors have to rely on the information available on the event date to estimate banks' tax aggressiveness. This approach is consistent with Abernathy et al. (2013). We split all listed banks according to the median ETR and then perform the data cleaning procedure described in Section 4.3. This can lead to slight numerical inequalities between the two ETR groups. The sample adjustment leaves us with 48 (56) treated banks with an ETR below (above) the median ETR. For the specification in column (3), the control group is split accordingly at the median ETR. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.106, 0.131 and 0.230, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

particularly exposed to the increase in tax transparency[41] and split our sample of treated banks accordingly. Information on the banks' activities in the selected tax havens is taken from the banks' CbCRs.

Table 29 shows the cumulative average abnormal returns for the subsample of banks with a presence vs. without a presence in the selected tax havens. The abnormal returns are in general negative and, in concordance with our expectations and the findings of Chen (2017) and Hoopes et al. (2018) in Australia, this negative effect is more pronounced for banks with a higher exposure to the CbCR obligation. However, the coefficients still lack statistical significance in conventional terms.

Next, we aim to split our sample according to banks' sensitivity to reputational concerns. Graham et al. (2014) and C. R. Austin and Wilson (2017) have recently documented the

Table 29: Engagement in selected tax havens sample split

	(1)	(2)
Expected return:	S&P Global 1200	MSCI World Banks
Banks not engaging in selected tax havens		
26-28 Feb 2013	-0.003	0.003
	(-0.412)	(0.374)
Banks engaging in selected tax havens		
26-28 Feb 2013	-0.009	-0.002
	(-1.016)	(-0.329)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Following Overesch and Wolff (2019), banks that have an entity located in either Cyprus, Ireland, Liechtenstein, Luxembourg or Malta are considered to engage in tax havens. We gather the relevant information from hand-collected CbCRs. If we cannot obtain information from the public CbCR, we check annual reports. We employ CbCR and annual report data for the financial year 2014 since this is the first year for which the full CbCR information has to be published. Despite a small time lag between financial year 2014 and our event date, we are confident that the tax haven activity at the time of the CbCR introduction is well reflected in the first wave of published CbCRs since it presumably takes time to react to the increase in tax transparency by withdrawing from tax havens. We reduce the sample to the treated banks for which we could find the relevant information. 66 (78) banks are part of a group without (with) an engagement in the selected tax havens. This test excludes the specification where the expected return is based on a control group of banks because comprehensive CbCRs are generally not available for banks with a global ultimate owner located outside the EU. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.229 and 0.253, respectively. t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

[41] Following Overesch and Wolff (2019), the five selected tax havens are characterized by a low population size and a comparably low GDP. In Appendix 11, we have included an alternative sample split according to the engagement in tax havens based on the broader tax haven classification of Hines (2010).

influence of reputational costs on companies' tax planning activities. With regard to financial institutions, a study of IBM (2009) has revealed that bank employees expect their clients to attach a very high value to reputation and integrity. Accordingly, Fiordelisi et al. (2014) describe reputation as a "key asset" for banks. An event study by Hanlon and Slemrod (2009) and survey evidence by Graham et al. (2014) has revealed that firms with more consumer orientation (proxied by firms in the retail industry) are more sensitive to reputational concerns. Consequently, we hypothesize that banks with a higher fraction of their total earnings depending on transactions with private customers should suffer more from a potential consumer backlash than banks that are largely focused on business customers. Thus, we try to distinguish between wholesale (i.e., B2B) and retail banks (i.e., B2C).

We use the "specialization" variable of Orbis Bank Focus as the basis for our sample split since it is sufficiently covered and specified consistently across different institutions. After inspecting several examples of banks allocated to the different categories of this variable, we uniquely assign each category either to B2C or B2B (see notes to Table 30). This information is stored in a dummy variable taking the value of 1 if classified as B2C and 0 if classified as B2B. As the specialization variable and, consequently, the dummy variable are available at the entity level, we match all entities that belong to the same group according to their global ultimate owner. For each bank group, we then calculate the fraction of B2C orientation as the simple average of the dummy variable of all entities in the same group. This B2C fraction is attributed to each publicly listed entity that belongs to this group. Finally, we partition our sample according to the mean value of the B2C fraction.

Table 30 documents the results of our sample split. While the stock price reaction in the three-day event window is more negative for the group of banks classified as having a higher B2C orientation, it is still small in size and insignificant. Thus, we find only weak evidence of a more negative investor reaction to the proposed increase in tax transparency for banks that are assumed to face higher reputational risks. However, we note several caveats to our

Table 30: B2B/B2C sample split

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-average B2C orientation			
26-28 Feb 2013	-0.003	0.001	0.001
	(-0.359)	(0.159)	(0.092)
Banks with an above-average B2C orientation			
26-28 Feb 2013	-0.009	-0.003	-0.008
	(-0.933)	(-0.305)	(-0.625)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Banks are classified according to the specialization code in Bank Focus: Commercial banks, Investment & Trust corporations, Investment banks, Private banking/ Asset management companies and Securities firms are assumed to be mainly B2B-oriented. Cooperative banks, Finance companies, Real Estate & Mortgage banks, Savings banks and Specialized governmental credit institutions are regarded to be mainly B2C-oriented. Central banks, Clearing and Custody institutions, Group finance companies, Islamic banks, Micro-financing institutions, Multi-lateral government banks and Other non-banking credit institutions are not considered. Consequently, 178 of 940 entities in the complete sample of banks listed on a stock market are categorized as B2C-oriented. At the group level, bank groups are classified to have a high or low B2C orientation depending on the fraction of affiliates with B2C orientation. We split all bank groups at the mean of the B2C fraction (about 20%). Hence, the treatment and control group are split in accordance. In the complete sample, about 30% of the bank groups are classified to have an above-average B2C orientation. Roughly in line with the ratio in the raw data, we have categorized 78 (43) treated banks as part of a group with a low (high) B2C orientation. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.295, 0.358 and 0.249, respectively. t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

approach. First, the Bank Focus financials database only contains information (including the specialization variable) for those subsidiaries of bank groups which have a bank license (Merz and Overesch, 2016). As this covers only a small fraction of subsidiaries, the actual B2C orientation of a bank group might differ from what we calculate based on the information available. Second, the different categories of the specialization variable do not always allow a clear distinction between B2C and B2B. Thus, several entities might be allocated imprecisely which can add noise to our results.

Finally, we split the sample according to the level of institutional ownership to analyze the channel of a reduction in information asymmetry separately. As Desai and Dharmapala (2006), Desai et al. (2007) and Bennedsen and Zeume (2018) have shown, tax avoidance strategies are regularly used by managers and controlling owners to extract private benefits. CbCRs can reduce information asymmetries between managers and shareholders by making

the magnitude of tax avoidance more transparent. It might therefore become more difficult for managers and controlling shareholders to hide expropriation activities from minority shareholders. Hence, the negative capital market reaction to an anticipated reduction in tax avoidance might come along with a positive reaction to the expectation of reduced information asymmetries and limited rent extraction. As stock owners holding a larger percentage of the shares of a company (such as institutional investors) usually have access to private information already, the benefits resulting from increased transparency should be more pronounced for firms with a high fraction of dispersed ownership (Bennedsen and Zeume, 2018). To examine this effect, we conduct our event study separately for banks with a low and a high share of institutional ownership.

Table 31 displays the results of our additional cross-sectional analysis. In line with our expectations, the overall reaction is less negative/more positive for the subsample of banks with a below-median share of institutional investors, i.e., for banks whose investors potentially benefit more from the additional disclosure. This finding might indicate that public CbCR can serve to reduce information asymmetries between managers and non-institutional investors. However, the overall results are still relatively small in size and we cannot conclude that the effect is significantly different from zero in conventional terms.

In conclusion, all four approaches to examine potential cross-sectional variation in the investor reaction provide some evidence on how different channels drive the response of the capital market. We conclude that the simultaneous impact of a reduction in tax avoidance possibilities and of a decline in information asymmetry, which might affect heterogenous groups of banks differently, may explain why our main finding suggests a zero reaction. Due to a relatively small sample size in our study, we might lack the power to obtain statistically significant results in sample splits. We thus leave it to future research to examine these channels in more detail.

Table 31: Ownership concentration sample split

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-median share of institutional investors			
26-28 Feb 2013	-0.003	0.003	-0.001
	(-0.324)	(0.469)	(-0.075)
Banks with an above-median share of institutional investors			
26-28 Feb 2013	-0.009	-0.003	-0.006
	(-1.251)	(-0.532)	(-0.679)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Banks are classified according to the proportion of institutional investors based on the shareholder data obtained from Bureau van Dijk's Orbis database, similar to Chen (2017). We use ownership data from the financial year 2013, which is our best proxy for the group structure at the event date. Based on this information on the investors, we calculate the share of institutional investors and split the sample at the median, which is at about 48%. We classify 71 (80) treated banks to have a below- (above-) median share of institutional investors. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.190, 0.162 and 0.268, respectively. t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

4.4.3. Discussion of Results in View of Prior Evidence

The different channels described and analyzed in detail should also prevail with respect to the new disclosure rule in Australia and the CbCR requirement for EU companies in the extractive industries. Thus, it is surprising that recent findings document significant investor reactions in these settings, whereas we do not observe a significant capital market response in our setting. Besides, the extant literature on Article 89 of the CRD IV provides some evidence that EU financial institutions actually changed their tax avoidance behavior after the introduction of the CbCR obligation. We therefore try to relate our finding to these prior results.

Both Overesch and Wolff (2019) and Joshi et al. (2020) find that EU financial institutions reacted to the new CbCR requirement to some extent by adapting their tax planning behavior. On the one hand, Overesch and Wolff (2019) document a decline in the extent of tax avoidance at bank group level. On the other hand, Joshi et al. (2020) observe that banks substitute profit shifting activities between subsidiaries that they consider to be within and outside the scope of the CRD IV, leaving the overall level of tax avoidance unaffected. In light of their findings and of our cross-sectional tests, our overall result should presumably not be interpreted as evidence

for investors expecting the CbCR obligation to be ineffective in curbing tax avoidance. Instead, as shown above, the increased transparency due to the CbCR disclosure may simultaneously limit the tax planning behavior of banks and reduce the possibilities of bank managers to extract private benefits. While Overesch and Wolff (2019) and Joshi et al. (2020) focus their analysis on tax avoidance and profit shifting and can therefore clearly separate the first channel, the capital market might incorporate both channels in its reaction.

Next, we try to understand possible reasons for the differing results between our study and prior analyses on the capital market reaction to increases in tax transparency. In the Australian setting, Hoopes et al. (2018) find a significant stock price decline around a decisive date in the legislative procedure. However, their research design differs fundamentally from ours as they are mainly interested in the incremental effect for companies expected to be disclosed as paying zero tax in Australia (compared to other firms also subject to the disclosure). Owing to this research question, they apply a difference-in-differences design as opposed to the event study methodology laid out by Kothari and Warner (2007). Moreover, they do not account for the distinct incentives created by the dividend imputation system. Due to these reasons, it is not feasible to directly compare the stock price effects documented by both studies. Nevertheless, we implement the design of Hoopes et al. (2018) in our setting as an additional robustness test (Appendix 12).

When considering a portfolio of Australian firms which should – even within the framework of the dividend imputation system – have pronounced incentives to minimize their corporate tax burden, Chen (2017) finds a negative and significant investor reaction aggregated over four event dates. However, the overall effect size of -0.01% observable in this specification is small in economic terms and lies within the range of our confidence intervals, i.e., we cannot exclude a comparably small stock market reaction in our setting. We also apply the design of Chen (2017) in our setting as an additional robustness test (Appendix 13).

In contrast, Johannesen and Larsen (2016) observe sizeable cumulative average abnormal returns of -2.3% to -6.0% around each of their two major event dates. These results clearly fall outside of our confidence intervals throughout all specifications, i.e., we can reject such a substantial negative stock price reaction for EU financial institutions at the 5% level. To identify the potential drivers of the conflicting findings, it is essential to compare the different settings exploited in our analysis and by Johannesen and Larsen (2016). Both event studies share important common features: The event dates are milestones within an EU legislative procedure which introduced a public CbCR obligation for EU companies in a specific industry. With respect to the geographic coverage, both rules require a full disclosure for all countries worldwide in which the corporate group is active. Moreover, both kinds of reports are published by the companies themselves, allowing for some discretion about the exact timing and design of the disclosure. These similarities ensure a sufficient degree of comparability between both settings.

A very obvious difference arises from the scope of the rules: While Article 89 of the CRD IV applies to EU financial institutions, Chapter 10 of the Accounting Directive targets companies active in the extractive industries or the logging of primary forests. It is possible that the introduction of public CbCR does not have the same effects across both industries. Since banks have traditionally been in a heavily regulated industry and were already subject to comprehensive disclosure obligations before the implementation of CbCR, investors might have expected that the new CbCR rule for the extractive industry reveals more material incremental information than in the financial industry.

However, despite the disclosure regulations existing before the CbCR enactment, financial companies scored among the worst in studies on transparency in corporate reporting conducted by Transparency International (2012, 2014). The results were extremely poor – and considerably worse than for extractive industry firms – in the category of country-by-country

disclosures.[42] Moreover, the extant empirical evidence of banks engaging in tax avoidance (Joshi et al., 2020; Langenmayr and Reiter, 2017; Merz and Overesch, 2016) is complemented by anecdotal evidence that the media and the general public are actually interested in information on this behavior: The Avaaz petition to enact a CbCR requirement achieved more than 200,000 signatures within less than two days. Several NGO studies analyzed small samples of published CbCRs and criticized the extensive tax haven usage of certain banks.[43] Furthermore, there are examples of financial institutions which increased the quality of their tax-related disclosures after being publicly accused of tax avoidance or evasion.[44] Finally, we know from recent literature (Joshi et al., 2020; Overesch and Wolff, 2019) that banks adjusted their tax planning behavior in response to the CbCR requirement. Taken together, these considerations do not suggest that the incremental information content of CbCRs or the public attention to tax planning behavior is per se weaker for banks than for companies in the extractive industries.

Instead, the discrepancy between our results and Johannesen and Larsen (2016) can arise from the different objectives of the respective CbCR rules. The idea of requiring natural resource companies to publish certain information on a by-country basis dates back to the Extractive Industries Transparency Initiative (EITI) launched in 2003. Its primary goal is to fight corruption, which has been identified as a major problem in the extractive industries and as a key driver of the so-called "resource curse". As a consequence, the main focus of these disclosure obligations is on payments between companies and governments (including tax

[42] The reports by Transparency International are based on very large companies and the evidence therefrom may not extrapolate to smaller firms. Kahl and Belkaoui (1981), Lang and Lundholm (1993) and Linsley et al. (2006) provide evidence of a positive relationship between firm size and disclosure adequacy (for banks and non-banks). We hence conclude that smaller banks are no more transparent in their public reporting than larger banks.

[43] Murphy (2015), Aubry et al. (2016), and Aubry and Dauphin (2017). Especially the analysis of Aubry and Dauphin (2017) for Oxfam received considerable media attention, causing headlines such as "European Banks Stashing Billions in Tax Havens" (EU Observer, 2017).

[44] E.g., Barclays was publicly denounced for maintaining a special "tax avoidance division" (The Guardian, 2013a, 2013c). As a reaction, the bank voluntarily published a complete CbCR (called "Country Snapshot") already for financial year 2013. This report (and all following ones) contains several additional tax items and explanations, trying to present Barclays as a responsible taxpayer.

payments).[45] By contrast, the CbCR requirement for EU financial institutions follows the goal of rebuilding trust in these institutions, which received enormous public subsidies in the course of the financial crisis (European Parliament, 2013). By imposing a CbCR obligation on banks, the public should be given the opportunity to assess whether they are paying their "fair share of taxes" in the countries where they operate. In this vein, the items to be reported by banks (as described in section 4.2) contain additional indicators of economic activity in each country.

The distinct objectives and resulting designs of both CbCR rules adopted in the EU provide a plausible explanation for the differences in the empirical findings. The sizeable negative stock price reaction for the extractive industries observed by Johannesen and Larsen (2016) could primarily result from investors' belief that the mandatory disclosure of payments between firms and governments effectively fights corruption and that companies have to increase their (legitimate) compensation to their host countries for extracted resources. This conjecture is also consistent with Rauter (2020) who documents corresponding real effects on payments of EU firms in the extractive industries after the CbCR introduction. This channel is not present in our setting, though, which can explain why the capital market reaction to the enactment of CbCR is more pronounced in the extractive industries than in the financial sector.

4.5. Further Analyses

4.5.1. Additional Event Dates

Prior studies have demonstrated the importance of considering multiple event dates, especially when investigating a legislative procedure (Abernathy et al., 2013; Chen, 2017; Donohoe and McGill, 2011). For this reason, we extend our analysis by two additional events, although noting some caveats regarding these dates.[46]

[45] The payment items to be disclosed by natural resource companies are production entitlements; taxes; royalties; dividends; signature, discovery and production bonuses; license fees, rental fees, entry fees and other considerations for licenses and/or concessions; and payments for infrastructure improvements.

[46] Another potential extension of our study would be to exploit the actual disclosure of banks' CbCRs as event date(s). However, they are usually published as part of the banks' annual reports or at least at the same point in time. This makes it difficult to disentangle investor reactions to the CbCR disclosure and to other information published in the annual reports. Hence, we concentrate on different dates in the legislative procedure.

Our first additional event is the publication of the CRD IV and the CRR in the Official Journal of the EU on 27 June 2013. This marks the final passage of the legislative package, removing any potential doubts whether the proposed CbCR rule would actually be incorporated into EU law. Appendix 14 shows the cumulative average abnormal returns for the three-day window centered on this alternative event date. Again, we do not find a significant stock price reaction for the banks affected by the new disclosure rule. However, as the CRD IV and the CRR contain a multitude of novel regulations for EU financial institutions (i.a. capital, liquidity and leverage requirements), different investor reactions to different kinds of rules might cancel each other out on average. Moreover, the final act of signing and publishing the law was probably not perceived as a surprise by investors as all relevant items had already been agreed upon in the months before.

Second, we exploit the fact that the CbCR obligation in Article 89 of the CRD IV was placed under the proviso that the European Commission conducts an impact assessment regarding potential negative economic consequences of the public disclosure of such information. Global systemically important institutions were required to confidentially report the CbCR items for the financial year 2013 to the Commission, providing a basis for their evaluation. The impact assessment study was prepared in September 2014 by PwC on behalf of the European Commission (PwC, 2014). On 30 October 2014, the European Commission reported to the European Council and the European Parliament that the public CbCR obligation was not expected to have a negative economic impact and could thus be implemented as foreseen in the Directive (European Commission, 2014). This represents our second additional event. As also depicted in Appendix 14, we do not observe a significant investor reaction in the three-day window centered on 30 October 2014. It seems questionable whether the result of the impact assessment was really perceived as a surprise by investors. Investors might have expected that the CbCR rule would actually come into effect once it was included in the CRD IV, irrespective of the proviso.

4.5.2. Robustness Tests

We conduct a series of robustness tests to increase the confidence in our results. First, we modify the event window. We shift the three-day event window to 25-27 February 2013 to capture potential anticipatory effects, but the results remain similar to our main specification. We also extend the event window and use a four-day window starting at the event date as well as a five-day window centered on the event date (Panel A of Appendix 15).

Second, we vary the abnormal return calculation. We replace the cumulative average abnormal returns by buy-and-hold abnormal returns, calculated as the average returns of a buy and hold strategy with geometric growth of returns. As buy-and-hold returns tend to be right-skewed (Kothari and Warner, 2007), we apply the skewness-adjusted t-test developed by Johnson (1978) as our relevant test statistic for this approach (Panel B of Appendix 15).

Third, we rerun our analysis with an alternative sample (Panel C of Appendix 15). Our baseline sample of treated firms described in section 4.3 contains only entities of bank groups whose global ultimate owner is located in the EU. Only these institutions are obliged to issue a CbCR for the whole group, revealing all tax haven subsidiaries and branches. In contrast, financial institutions headquartered in third countries only have to publish a report for their EU establishments, which makes it impossible to judge their worldwide tax planning activities. Nevertheless, investors might not have completely comprehended this difference in the scope of the new rule and might just have associated a bank's EU nexus with an upcoming CbCR requirement. We take account of this concern and adjust our sample so that the treatment group contains all banks listed in the EU (irrespective of the location of the global ultimate owner). The control group used to calculate abnormal returns is adapted accordingly.

Furthermore, we replace the event study design as laid out by Kothari and Warner (2007) by alternative event study methods. First, we implement a multivariate regression model similar to Frischmann et al. (2008) and Abernathy et al. (2013). More precisely, we add a dummy variable taking the value one for each day of the event window to the market model. The

coefficient estimates on the dummy variable reflect the abnormal returns (Appendix 13). Second, we replicate the event study conducted by Hoopes et al. (2018) for our event date. In line with our prior setting, we use banks with a global ultimate owner located in the EU as the treatment group and banks whose global ultimate owner is located in a non-EU country as the control group. The results are depicted in Appendix 12.

Finally, we conduct a series of robustness tests for our main event specification and the heterogeneity analysis in Appendix 16 to Appendix 33, where we apply more restrictive samples of treated banks. First, we limit the initial treatment group to entities which both belong to an EU-headquartered bank group and are themselves located in an EU country as these entities should have the strongest exposure to the CbCR introduction (Appendix 16 - Appendix 21). Second, to exclude potential noise resulting from banks located in countries with only few observations, we restrict the treatment group further to entities located in EU countries with at least ten listed banks (Appendix 22 - Appendix 27). The control groups are adjusted accordingly in both sets of tests. Third, to account for potentially differing profit shifting incentives of listed subsidiaries due to the existence of minority shareholders, we only consider treated banks which are the global ultimate owner of a bank group (Appendix 28 - Appendix 33).

Throughout all these robustness tests, the results remain qualitatively similar and our main inferences do not change. We do not find a statistically significant overall stock price reaction around the event day that we can trace back to the CbCR introduction.

4.6. Conclusion

In recent years, several initiatives have proposed and implemented CbCR requirements for multinational firms. These new disclosure obligations are supposed to curb extensive tax avoidance by providing additional information to tax authorities and – if reports are made publicly available – by public pressure being exerted on companies. Due to the recent nature of all CbCR rules, empirical evidence on the effectiveness of this kind of tax transparency measure is still scarce and inconclusive. In our study, we examine how investors evaluate the enactment

of a CbCR requirement for EU financial institutions (Article 89 CRD IV). On the one hand, investors might appreciate the upcoming enhancement in tax transparency, providing them with incremental information about the firms and reducing information asymmetries between shareholders and managers. On the other hand, investors could expect that the affected companies will subsequently reduce the extent of their tax avoidance activities (as intended by the legislator) and/or will face substantial reputational costs.

Prior event studies by Chen (2017), Hoopes et al. (2018) and Johannesen and Larsen (2016) document negative capital market responses to the introduction of similar tax disclosure rules for large Australian firms and for EU firms in the extractive industries, respectively. Their findings suggest that the channels of increased tax authority and public scrutiny dominate investors' perception of new tax disclosure requirements. Consequently, we also expect a negative reaction in our setting. This expectation is corroborated by early empirical evidence indicating that banks changed their tax avoidance behavior after the implementation of the CbCR obligation (Joshi et al., 2020; Overesch and Wolff, 2019).

We employ an event study methodology to analyze the stock price reaction around the day of the surprising political decision to introduce a CbCR obligation for EU financial institutions. Our results are suggestive of a zero response in our full sample of financial institutions headquartered in the EU. We conduct several sample splits and find that the reaction is slightly more negative for banks engaging in selected tax havens and banks with an above-average B2C orientation, and slightly more positive for banks with a below-average share of institutional investors, albeit still insignificant. Our inferences remain unchanged when considering two additional event dates and throughout various robustness checks.

We link our finding to previous studies on tax transparency. Recent evidence suggests that financial institutions reacted to the new CbCR requirement by adjusting their tax planning behavior (Joshi et al., 2020; Overesch and Wolff, 2019). Prior literature has shown that tax avoidance and the extraction of private benefits by managers and controlling owners are

complementary (Bennedsen and Zeume, 2018; Desai and Dharmapala, 2006; Desai et al., 2007). Taking together these findings and our result, we conclude that investors anticipated both a reduction in the tax avoidance opportunities and a decline in managers' expropriation activities due to reduced information asymmetries between managers and shareholders. These expectations might trigger both negative and positive capital market reactions, offsetting each other on average.

While the modest negative stock market reactions documented by Chen (2017) and Hoopes et al. (2018) in response to a new disclosure requirement in Australia still lie within our confidence intervals and/or can potentially be traced back to the different research design, we can exclude the occurrence of a reaction as strong as observed by Johannesen and Larsen (2016) for the EU extractive industries at the 5% level. Comparing the settings analyzed by Johannesen and Larsen (2016) and in our study, we conjecture that differences in the list of disclosure items due to the distinct objectives of both transparency rules explain the different perceptions by the capital market. Investors expected the CbCR of EU extractive industries to effectively fight corruption, while this channel is not at work in our setting.

Overall, we provide more insights into the expectations that go along with the CbCR requirement for EU financial institutions. Our findings are especially relevant for policymakers deciding upon the implementation of additional tax disclosure rules. For instance, the European Commission and the European Parliament have recently drafted proposals to adopt a public CbCR requirement for all multinational firms with profits above a certain threshold (European Commission, 2016; European Parliament, 2017, 2019b).[47]

[47] In 2021 the European Council reached a political agreement to introduce a public CbCR for large multinational corporations (European Council, 2021).

5. Investor Reaction to the European Commission's Digital Tax Proposals[48]

5.1. Introduction

To curb tax avoidance of digital firms and to increase tax revenues within the European Union (EU), on March 21, 2018, the European Commission published a "digital tax package" containing two proposals for tax measures directly targeted at a single industry: the digital economy (European Commission, 2018a). The first proposal suggests the immediate introduction of an interim Digital Services Tax (DST) of three percent on gross revenues from certain digital services of large digital firms, deviating from the current system of taxing corporate profits. The second proposal lays down the rules for taxing corporate profits that are attributable to a significant digital presence in the long-run.

In this study, we analyze whether investors perceive the introduction of digital tax measures as a threat to future profitability. We also analyze heterogeneous effects depending on the specific characteristics of digital firms. In doing so, we provide evidence regarding whether investors understand and react to legislative drafts' underlying intentions.

Since firm-specific costs and benefits will ultimately be reflected in a change in firm value, we focus on the proposals' effect on firm value. The observable change in firm value is a combination of investors' expectations of the effects of the proposed measures on a firm's future profitability and the ex ante probability of enactment (Wagner et al., 2018a). At the time of the proposals' release, it was seen as very likely that a new measure, such as the DST, would

[48] This section is joint work with Daniel Klein and Christoph Spengel. It has been accepted for publication in the *National Tax Journal*. We thank Stacy Dickert-Conlin (co-editor), Matthew Erickson (discussant), Bill Gentry (editor), Jost Heckemeyer, Katharina Nicolay, Marcel Olbert, Josh Rauh, Kurt Schmidheiny (discussant), Arthur Stenzel (discussant), three anonymous referees, the participants of the EAA 2021 Virtual Congress, the ATA Midyear Meeting 2020, the CEPR Business Taxation Workshop St. Gallen 2020, the National Tax Association's 112th Annual Conference on Taxation, the sixth annual MannheimTaxation Conference, the participants of the ZEW Public Finance Conference, the participants of the joint Walter Eucken Institute and ZEW workshop and the participants of the Accounting and Taxation Brownbag Seminar at the University of Mannheim for their valuable suggestions and comments. We gratefully acknowledge financial support from the Graduate School of Economic and Social Sciences of the University of Mannheim, from the Leibniz ScienceCampus MannheimTaxation and the Leibniz Association (Taxation in the Era of Digitalization).

become effective.[49] Pierre Moscovici, Commissioner of Taxation, stated on March 21, 2018, "Digital taxation is no longer a question of 'if' – this ship has sailed" (European Commission, 2018b).

We employ a short-term event study design to measure investor reaction and find a significant cumulative average abnormal return of -0.692 percent in response to the release of the proposals. This finding suggests that investors, on average, perceive the increased likelihood of the introduction of digital tax measures as negative news for firms' future profitability. Moreover, it suggests that investors perceive the demand for digital services to be not perfectly inelastic so the capital market expects that digital firms will be unable to pass through all of the additional tax expenses.

To evaluate whether investors react in line with the proposals' intention, we analyze the variation of abnormal returns across firm characteristics. The proposed tax measures are designed to reach two specific goals: first, to safeguard national tax revenues from large digital firms in the European Union that are perceived to avoid taxation (European Commission, 2018e; Fuest et al., 2018), and second, to extract part of the location-specific rent of digital firms, which is expected to emerge through high user involvement in market countries, i.e., countries with many consumers (Cui, 2019; Cui and Hashimzade, 2019; European Commission, 2018e). These objectives are particularly reflected in the conception of the DST proposal, including arbitrarily chosen size thresholds and the taxation of revenues in market countries.

In line with the first objective, we find that a negative abnormal return is significantly stronger for firms that engage more in tax avoidance and for firms that have higher profit shifting potential. This is attributable to the fact that the mechanisms to avoid corporate taxation

[49] The finance ministers of the EU member states have expressed a large interest in a temporary digital tax measure and the EU Commission explicitly points out that "this proposal answers these calls for action, and addresses in an interim way the problem that the current corporate tax rules are inadequate for the digital economy" (European Commission, 2018a). Hence, from the political context in March 2018 investors and corporate managers could expect with some certainty that a DST will be introduced.

or to relocate net income are not applicable to the proposed gross revenues DST.[50] Our finding suggests that firms receive a market premium for tax avoidance and that the premium diminishes when the European Commission releases the "digital tax package". In line with the second objective, we find that the stock market reaction is more severe for firms with a higher proportion of revenues generated in the EU. Overall, the investor reaction reflects the intention of the European Commission's proposals to secure tax revenues and to extract location-specific rent, suggesting that the capital market expects that the proposals' objectives are achievable.

Furthermore, we examine the magnitude of the observed market reaction. We estimate the total abnormal market value change to be at least -52 billion euros over the two-day event window. Approximately 40 percent of the economically meaningful reduction is attributable to firms located in the United States (U.S.), supporting the argument that a DST will mainly affect large U.S. firms. It remains questionable whether additional tax revenues, which are estimated to be approximately 3.9 to 5 billion euros per annum, can outweigh the effect on shareholders' wealth (European Commission, 2018c; Fuest et al., 2018). Based on a theoretical present value evaluation, we estimate that it will take at least six years for the additional tax revenues to compensate for the initial drop in shareholder wealth. The magnitude of the abnormal market value reduction further indicates that investors do not expect that the DST will quickly be repealed.

Our analysis adds to the recent call in the literature for empirical research on the proposed measures of taxing the digital economy and the adaptation of the international tax framework to the digital era (Devereux and Vella, 2018; Olbert and Spengel, 2019). While prior studies mostly focus on a technical evaluation of the DST and a virtual permanent establishment concept (Becker and Englisch, 2018; Cui, 2019; Nieminen, 2018; Russo, 2019; Vella, 2019), the literature is largely silent about the economic effects of such measures on firms. However,

[50] Note that the DST is deductible from the corporate income tax base. Hence, firms that currently pay more corporate income tax will be able to deduct more of the DST paid. If firms are unable to avoid the DST on gross revenues, the effective tax burden of firms that avoid corporate income taxes will increase relatively more.

such an evaluation is especially critical against the background of ongoing tax discussions at the level of the OECD and unilateral actions of several jurisdictions to introduce a DST (Pellefigue, 2019; Vella, 2019). Our results indicate that policymakers should be aware that investors perceive digital taxes as a threat to firms' profitability. The economic effects of reduced profitability and growth disincentives of digital companies may outweigh potential tax revenue benefits.

Furthermore, this paper complements the literature that examines the effect of anti-tax avoidance policies to safeguard tax revenues. Prior research shows that the introduction of anti-tax avoidance policies, such as thin capitalization rules or controlled foreign company rules, have positive tax revenue effects for governments and lead to real effects at the level of the firm in the form of altered capital structures and investment behavior (Blouin et al., 2014; Clifford, 2019; de Mooij and Liu, 2021; Egger and Wamser, 2015). Our results indicate that firms receive a market price premium for higher tax avoidance activities which the proposed digital tax measures effectively diminish.

Moreover, we contribute to the mixed evidence on the elasticity of demand in the digital economy. On the one hand, Einav et al. (2014) and Baugh et al. (2018) found a relatively high elasticity of demand for online sales over platforms such as eBay or Amazon. On the other hand, Cohen et al. (2016) and Bibler et al. (2020) show that demand is relatively inelastic on sharing economy platforms. Our capital market analysis reveals that investors expect to bear some of the incidence of the digital tax package and perceive the elasticity of demand for digital services to be relatively high.

Finally, our study contributes to the literature concerned with the effect of tax reforms on shareholder value. Doidge and Dyke (2015) show, among others, that additional corporate taxes imply a negative effect on firm value. Several studies analyze the stock market reaction in response to the recent U.S. tax reform and find heterogeneous stock price reactions across firms and countries (Gaertner et al., 2020; Overesch and Pflitsch, 2021; Wagner et al., 2018b).

Hoopes et al. (2016) analyze the events around the U.S. sales tax reform for online retail companies. Their study provides evidence of negative abnormal returns for targeted online retailers. Different studies find inconclusive results on investor reaction to the introduction of mandatory tax disclosure rules in Europe and Australia (Chen, 2017; Dutt, Ludwig, et al., 2019; Hoopes et al., 2018; Johannesen and Larsen, 2016). To the best of our knowledge, we are the first to examine the stock market reaction in response to reforms on taxing digital corporations.

5.2. Institutional Background and Hypotheses Development

5.2.1. The Digital Tax Initiatives in the European Union

Despite the innovative character of most digital business models and their positive contribution to economic growth, digital firms are repeatedly subject to intensive public and political debate on their tax avoidance activities.[51] The dependence on a physical presence for the establishment of a taxable nexus, which is a central feature of the existing international tax framework, poses a significant challenge for the taxation of cross-border transactions of digital businesses. In response, the European Commission published a "digital tax package" on March 21, 2018, containing two proposals that are concerned with the taxation of digital activities and services (European Commission, 2018a, 2018d, 2018e). The first proposal aims to introduce a new EU-wide DST on revenues from certain digital services as an interim solution. The second proposal focuses on a long-term solution, presenting rules and provisions for the corporate taxation of a significant digital presence (European Commission, 2018d).

The DST constitutes a gross revenue tax of three percent.[52] Those revenues that result from the provision of three types of digital services are taxable: first, the placement of advertising on digital interfaces targeted on users of that interface; second, the provision of

[51] The effective tax rate of big tech companies is regularly discussed in the public media and Margarethe Vestager, European Commissioner for Competition, has become publicly known for her focus on illegal state aid cases and tax affair investigations (see, e.g., Bloomberg, 2019; Financial Times, 2018b; The Guardian, 2018).

[52] In contrast to net income, the management of the gross revenue figure on the income statement is to a lesser extent at the discretion of firms.

digital interfaces to users, which allow users to find each other, to interact and to exchange goods and services; and third, the transmission of user data generated from users' activities on digital interfaces (European Commission, 2018e). The DST paid is deductible from the corporate income tax base.

The proposal suggests limiting the DST to firms that exceed two size thresholds. First, the consolidated amount of worldwide company turnover must exceed 750 million euros within a financial year. Second, the total amount of taxable revenues within the EU – those revenues that are taxable under the scope of the DST – must exceed 50 million euros in the same financial year (European Commission, 2018e).[53]

The second proposal of the European Commission aims for a comprehensive solution for the long run. It intends to establish a new taxable nexus for firms that maintain a non-physical but significant digital presence in one or more EU member states. Using a significant digital presence as a taxable nexus extends the existing physical permanent establishment concept by the concept of a "virtual permanent establishment." According to the proposal, a significant digital presence exists in a member state if a firm supplies digital services through a digital interface and meets one or more of the following thresholds of digital activity in a member state in the tax period: first, revenues from supplying digital services to users exceed 7 million euros; second, the number of users of digital services exceeds 100,000; or third, the number of business contracts concluded for the supply of digital services exceeds 3,000 (European Commission, 2018d).

Overall, the finance ministers of EU member states have expressed a large interest in a temporary digital tax measure.[54] The EU Commission points out that the DST proposal "answers these calls for action, and addresses in an interim way the problem that the current corporate tax rules are inadequate for the digital economy" (European Commission, 2018e).

[53] The explanatory memorandum in the proposal limits the scope of the DST to corporations.
[54] Council Conclusions of 5 December 2017 – Responding to the challenges of taxation of profits of the digital economy (FISC 346 ECOFIN 1092).

Consequently, the DST proposal contains detailed provisions on the tax subject, the tax base, and the tax rate. In contrast, the European Commission explicitly states that the proposal concerning the corporate taxation of a significant digital presence is thought of as a long-term solution and subordinate to a multilateral agreement at the level of the OECD. As a result, the proposal's conceptual framework is not as developed as that of the DST proposal.

Despite the European Commission's effort to gain political agreement on the DST proposal as a "quick fix" for the international tax framework, member states could not reach a collective understanding.[55] The two concepts remain formal proposals, and the European Commission indicated that it may revive the proposals if no consensus at the level of the OECD is reached.[56] The European Commission's vice president recommended that member states use the DST proposal as a framework for legislative actions at the national level.[57] Several countries followed this recommendation and started to introduce a DST unilaterally.[58] As of the beginning of 2021, the European Commission restarted the formal process to introduce a DST.[59] The political and academic debate on digital tax measures is ongoing and empirical insights into the economic effects of such methods are highly valuable.

5.2.2. Implications of the Digital Tax Package and Hypotheses

It is widely accepted that tax policy changes may have significant effects on stock prices and that it is crucial to be aware of the potential effects (Doidge and Dyck, 2015; Downs and Tehranian, 1988). In general, stock prices are related to the cash flow distributions expected to be generated by the firm and incorporate all available information of the market (McWilliams and Siegel, 1997). Therefore, ceteris paribus and without perfectly inelastic demand, additional

[55] See for the main results of the ECOFIN meetings on December 04, 2018, and March 12, 2019 (European Council, 2018, 2019).
[56] As of 2021, the OECD member states are proceeding with an initiative to reframe the international corporate tax system. The OECD proposes a corporate tax reform that intends to shift taxing rights to the market jurisdiction and to introduce a global minimum tax and deduction disallowance (OECD, 2019).
[57] See Debate in the European Parliament on April 15, 2019 (European Parliament, 2019a).
[58] The Tax Foundation provides an overview on the countries (Tax Foundation, 2021).
[59] In January 2021, the European Commission started a public consultation process to introduce a digital tax to address the issue of fair taxation of the digital economy (European Commission, 2021).

corporate taxes intuitively and negatively affect a firm's stock price as they reduce the after-tax cash flow (DeAngelo and Masulis, 1980; Doidge and Dyck, 2015; Wagner et al., 2018a).[60]

With regard to the digital tax package, stock prices might be affected both by the interim digital services tax proposal and by the proposed long-term tax reform for digital companies. From the proposals' different levels of conceptual detail and the political context in March 2018, investors and corporate managers could expect with some certainty that the DST will be introduced while the adoption of the significant digital presence proposal was always doubtful (Cui, 2019). Thus, we assume that investors mainly evaluate and react to the proposed DST. However, throughout the paper, we will reflect on this assumption. Academics and practitioners immediately and heavily criticized both proposals for being populist and shortsighted (e.g., Fuest et al., 2018; Næss-Schmidt et al., 2018; Spengel, 2018). With regard to the detailed proposal of a DST, prior literature points out that a gross revenue tax deviates from the conceptual fundamentals of the existing tax framework of corporate profit taxation and that this addition to the existing system is likely to create a complex and discriminatory tax system that distorts competition and harms the position of EU member states in terms of international tax competitiveness (CFE Fiscal Committee, 2018; Petruzzi and Koukoulioti, 2018; Sheppard, 2018; van Horzen and van Esdonk, 2018).

In contrast to the corporate income tax, which is a net profit tax, the DST is, in essence, an additional *ad valorem* excise tax. The statutory incidence of the proposed DST lies on the producer side and is not levied per customer transaction but on an aggregate level on the overall revenues from digital services. However, the economic incidence of an excise tax is not clear upfront. Prior literature shows that the demand for digital services on sharing economy platforms is relatively inelastic but that additional sales taxes on e-tailers can lead to a quite elastic change in demand (Baugh et al., 2018; Bibler et al., 2020; Cohen et al., 2016). Research

[60] While the 'asset price' models of shareholder incidence take general equilibrium effects from the taxation of existing and new assets into account, we lean on the 'cash flow' model of incidence, which leaves relative price effects of tax reforms aside (Cutler, 1988).

also shows that comparable excise taxes on products with inelastic demand functions, such as gasoline or alcohol, can be fully passed-through (Hindriks and Serse, 2019; Marion and Muehlegger, 2011). To the extent that the incidence of the additional tax burden is not on customers or labor, owners will bear the burden of the newly proposed DST.

Due to the inverse relation between corporate profitability and the effective tax burden, the effect of a gross revenue tax on the after-tax cash flow may well exceed the burden of an income tax.[61] This may cause severe consequences for firms with relatively low profit margins in terms of competitiveness, forcing these firms to either raise prices or go out of business.

Furthermore, the fixed thresholds lead to the undesirable effect that around the limit value, additional gross income reduces the net income of a firm. In the same vein, distortion of competition is conceivable, as one competitor, slightly above a threshold, would have to pay the tax, while another competitor, slightly below the relevant threshold, would be tax-exempt. As a consequence, large digital firms are subject to an additional tax, even though several researchers show the impracticability and distortive effect of such practices (Olbert and Spengel, 2019; Schön, 2018). Simultaneously, the broadly defined digital service revenue categories increase the risk that the scope of firms affected by the proposed digital tax measures is overshooting.[62] In addition, the newly proposed measures introduce considerable tax uncertainty for affected firms, and prior literature has shown that this increasing uncertainty is positively associated with costly cash holdings (Hanlon et al. 2017).

Based on the findings in prior literature and our assessment of the European Commission's proposals, we expect a mean negative investor reaction in response to the European Commission's communication and extensive media attention on March 21, 2018.

[61] A three percent gross revenue tax translates to a 30 percent income tax for firms with a profit margin of 10 percent and to a 60 percent income tax for firms with a profit margin of 5 percent.

[62] Non-digital corporations such as the New York Times or the German publishing company Springer, which have a growing online business model, would be subject to the proposed digital taxes.

H1: The abnormal stock price reaction in response to the European Commission's digital tax proposals is negative for affected firms.

In addition, digital tax proposals are motivated by the widespread political perception that digital firms pay fewer taxes (European Commission, 2018d; OECD, 2015a). The European Commission promotes newly proposed measures to compensate tax revenue losses from aggressive profit shifting. The design of both proposed measures intends to safeguard tax revenues and allocate taxing rights to market jurisdictions (European Commission, 2018a). The interim digital services tax is designed as a non-avoidable gross revenue tax and the virtual permanent establishment proposal is designed as a countermeasure to base erosion in market jurisdictions. Hence, we expect that the proposals will have larger effects on firms that engage more in tax avoidance and firms with more profit shifting potential.

H2: The negative stock market reaction is more pronounced for digital firms that avoid taxes more or have more profit shifting potential than others.

Moreover, the proposals' objective is to extract part of the location-specific rent of digital businesses (Cui, 2019; Cui and Hashimzade, 2019). The European Commission considers digital firms' business models to rely heavily on users and assumes, in line with Evans and Schmalensee (2010), that they play a vital role in the value creation process by creating network effects. Given that these users are located in the EU, a fair share of taxation should be allocated there (European Commission, 2018a). In this regard, the DST is designed to explicitly apply to the location-specific digital revenues generated within the EU single market. As the precise amount of such taxable revenues is hardly observable, investors may consider the overall engagement in the European market as a proxy to evaluate whether a firm is affected. We expect that the stock market reaction is more negative for firms with a greater share of revenue attributable to the European market. Since the tax burden of the DST is proportional to revenues rather than profits, we also expect that the capital market reaction is in absolute terms larger for firms with higher revenues. Furthermore, investors might perceive the proposals as a threat to

firm growth and expect that loss-making firms might not have the necessary funds to finance the additional taxes on gross revenues. Hence, we expect investors to differentiate their response depending on a firm's characteristics.

H3: The negative stock market reaction is more pronounced for digital firms with a greater share of revenue in the European market, larger digital firms, digital firms in a state of loss, or digital firms with higher growth potential.

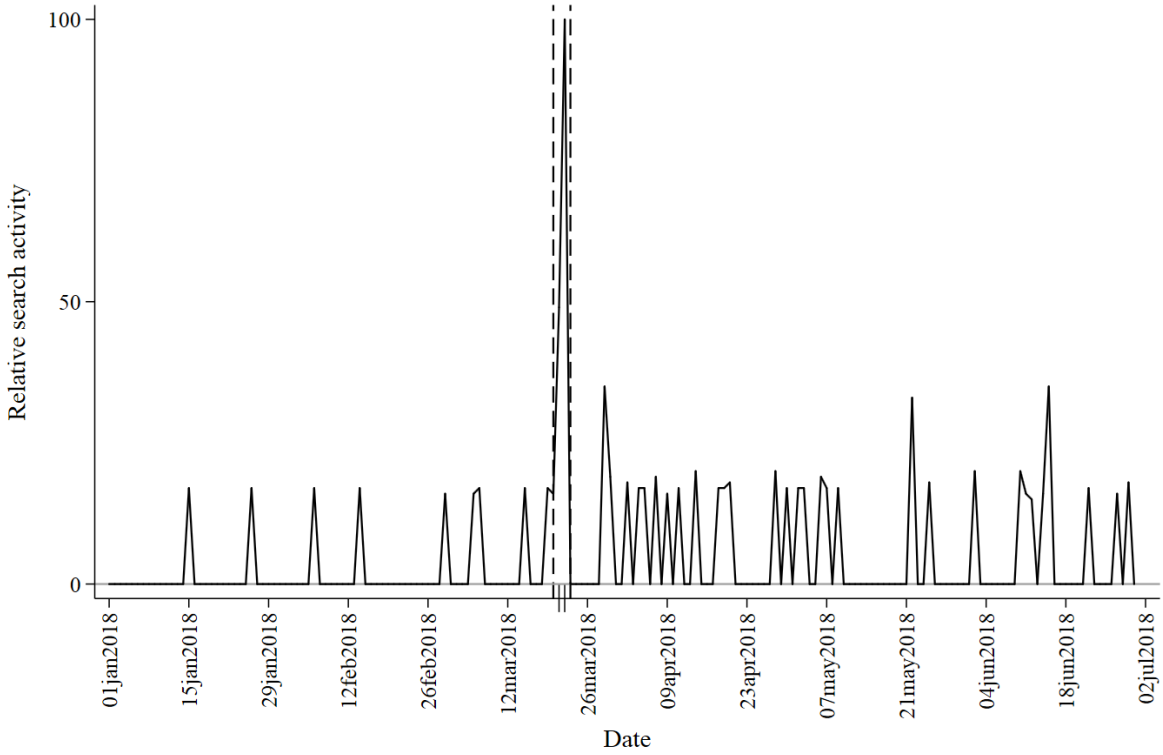
5.3. Data and Research Design

We conduct an event study to estimate the effect of the proposed "digital tax package" on the stock returns of affected firms. The event study methodology, which measures the magnitude of the effect an event has on the expected profitability, is based on three assumptions. First, we assume markets are efficient. Hence, we interpret the change between the pre-event and after-event price of a stock, adjusted by general market movements, as the market's unbiased estimate of the effect of that event on the value of a firm and the wealth of investors (Fama et al., 1969; Kothari and Warner, 2007). Second, we assume that market participants were not aware of – and did not anticipate – the digital tax package's detailed content before its release by the European Commission and only subsequently started to process and incorporate the relevant information into stock prices. Third, we rely on the assumption that no confounding event systematically affects the stock market reaction of treated and control firms around the event date.

To support the adequacy of our assumptions, we undertake several analyses. In line with prior studies, we first conduct a Google Trends analysis to capture the event date that is most likely to be relevant for the stock price effect (Gaertner et al., 2019, 2020). Google Trends provides the frequency of search requests on a specified topic of interest over a time horizon as

an index value. Figure 17 depicts the Google Trends analysis for the term "EU Digital Tax".[63] We can see a considerable spike on March 21, 2018, which corresponds to the date the European Commission released the proposals accompanied by a major press release. The interest in the EU Digital Tax proposal reached an even higher level on March 22, 2018. Second, we analyze the media attention toward the EU Digital Tax proposal, which follows a similar pattern. We use the global news database Factiva to systematically search newspapers and media reports for the coverage of the digital tax proposals over time. Appendix 34 shows the number of articles on that topic per day. Most articles on the EU Digital Tax were published on March 21,

Figure 17: Google Trends Index for "EU Digital Tax" over the first half of 2018



Notes: We plot the Google Trends Index for "EU Digital Tax" over the first six months of 2018 when EU policymakers were actively working on the digital tax proposals. The index (y-axis, relative search activity) varies from 0 to 100, where 100 represents the highest search activity for a specific time period. All other search activities are displayed relative to the highest search activity. The local peaks correspond to periods of relatively high search activity regarding "EU Digital Tax" and comprise our events of interest. The dates enclosed by the light grey scattered lines are our event window. The crossing ticks on the x-axis represent March 21 and March 22, 2018, respectively.

[63] We search for several terms that could relate to the EU digital tax proposals, such as: "Digital Tax", "EU Commission Proposal", "Digital Services Tax", "Digital Permanent Establishment" "Significant Digital Presence". All terms lead to similar patterns around the release of the directive proposals. Our main specification relies on the most commonly used term to describe both proposals: EU Digital Tax. Furthermore, for the term "EU Digital Tax" most searches stem from the UK followed by the U.S. We find the same spike using the key words in other languages, for example, German ("EU Digitalsteuer"). The top country searches in our event window for the term "Digital Tax" originate from Ireland, UK, Sweden and the U.S.

2018, and the day after. Especially, major U.S. newspapers reported on March 21, 2018 (New York Times, 2018; WSJ, 2018). Ultimately, we include March 21, 2018, and March 22, 2018, the days with the highest online search activities and media attention, in our event window.

In the next step, we check that no decisive information regarding the detailed content of the digital tax proposal has entered the market before our event window. First, considering the importance of major accounting firms for analyst and shareholder information, we search the websites of the Big Four accounting firms to see when they first report about the tax proposals. While KPMG, Deloitte and PwC publish their first statements on our event date March 21, 2018, EY does not report until March 22, 2018. Second, we use the Edgar advanced full-text search to systematically search for different keywords regarding digital taxation in all available 10-K reports of the last ten years.[64] Overall, we find 98 10-K reports speaking about digital taxation. However, none of them mentions digital taxation before March 2018. We provide the results in Appendix 35. In addition, for every U.S. firm in our treatment group, we hand-search the respective 10-K statements regarding digital taxation. We find that none of the treated U.S. firms mentions digital taxation in their annual report before March 2018. We further find that 14 of the 88 US firms in the treatment group actively report digital taxation as a risk factor, often explicitly mentioning the EU Commission's proposals. We outline the statements in Appendix 36. This analysis suggests that our event window in March 2018 measures the indicated effect and that digital taxation is seen as a threat by digital firms. It also suggests that no detailed information has been incorporated into stock prices beforehand. However, if this were the case, this should rather attenuate potential stock market reactions.

Finally, we again use the global news database Factiva to search for topics that could alternatively and systematically affect digital firms' stock price movement in our event window. We search all newspaper articles in the Wall Street Journal (WSJ), Washington Post, New York

[64] We search for the terms "digital services tax", "digital service tax", "digital services taxes", "digital service taxes", "digital tax", "taxation of the digital economy", "taxation of specified digital services" and "taxation of digital services" in the Edgar database: https://www.sec.gov/edgar/search/#.

Times and The Guardian on March 21, 2018, and March 22, 2018, and create clusters by counting the number of articles referring to the same topic. We provide the results of our search in Appendix 37. In addition to the release of digital tax proposals, we identify two other clusters with heightened media attention. First, the apology of Mark Zuckerberg, CEO of Facebook, after Facebook collaborated with a third-party company that improperly kept and used Facebook's user data. Second, U.S. President Trump's announcement of potential tariffs against Chinese origin goods as well as steel and aluminum imports. However, we are confident that none of the identified clusters confound our results since the Facebook data scandal had already become public on March 17, 2018. International trade conflicts should lead to general market movements rather than to systematic reactions against digital firms. In particular, by using the market model or a portfolio of all non-digital firms for estimating abnormal returns, the results should be robust against the identified clusters. Hence, the release of the proposed directives is, to the best of our knowledge, the only event that could affect all digital firms targeted by the directives' specifications. Moreover, in contrast to other European Commission directives, the proposed measures were not part of a broader policy package that could confound the analysis.[65]

We select treated firms based on the characteristics outlined in the proposals. We base our sample selection procedure on two studies that estimate the expected additional tax revenue from the proposed digital services tax (European Commission, 2018c; Fuest et al., 2018). We use data from the Bureau van Dijk ORBIS database to identify all publicly listed corporations with consolidated worldwide turnover above 750 million euros in the last financial year known at the time of the proposal. In line with the study of Fuest et al. (2018), we restrict the sample to firms active in industries that are likely to fall in the scope of the "digital tax package".[66] There are 192 corporations that satisfy the size and industry criteria. Furthermore, accompanying the proposals, the European Commission released an impact assessment. It

[65] See, for example, the introduction of country-by-country reporting for banks, which was part of the major Capital Requirements Directive IV (Dutt, Ludwig, et al., 2019).
[66] The relevant NACE Rev. 2 codes are: 6201, 6209, 6311, 6312, 4791 and 5811 to 5819.

explicitly refers to 112 top digital corporations that are assumed to be affected by the measures (European Commission, 2018c; United Nations Conference on Trade and Development, 2017). We add 58 listed firms to our sample that are named in the impact assessment and exceed the size threshold but are not captured by our initial classification.

We obtain one year of daily stock market data from the Thomson Reuters EIKON database ending ten trading days after our event date. We use the return index (RI), which shows the theoretical value of a shareholding, assuming that dividends are reinvested to purchase additional shares at the closing price applicable on the ex-dividend date as a base for our daily return calculations.[67] In line with Frischmann et al. (2008) and Dutt, Ludwig et al. (2019), we drop 22 firms without sufficient stock market information and trading activity. Finally, we exclude six corporations that had an earnings announcement immediately before, on or after the event date to eliminate all stock market reactions not directly linked to the proposals. Overall, our final sample consists of 222 corporations, which are listed in Appendix 38.[68] We show descriptive statistics for the sample in Table 32. The average daily stock return of treated firms is 0.08 percent, with a standard deviation of 1.65 percent.

For our main analysis, we follow the event study design of Eckbo et al. (2007) and Frischmann et al. (2008). Our event window covers the day of the release of the proposals, March 21, 2018, and the subsequent day (0 through +1). We set our estimation window to contain trading days -11 through -250 relative to the event day. We estimate the following conditional market model:

$$R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}. \quad (12)$$

[67] With P_{it} as share price of firm i on day t, $RI_{it} = RI_{it-1} \times \frac{P_{it}}{P_{it-1}}$. Except when t equals the ex-dividend-date, then: $RI_t = RI_{t-1} \times \frac{P_t + D_t}{P_t - 1}$ with D_t being the dividend payment associated with the ex-date. Based on this price information, daily (total) returns ($R_{i,t}$) are calculated. Daily returns are winsorized at the one and 99 percent level, which amount to -5.136 percent and 5.618 percent, respectively. We acknowledge the view that winsorizing return data may distort the 'true' market movement. Untabulated tests reveal that our inferences remain unaffected if we use non-winsorized returns.

[68] The DST has been accused of directly targeting U.S. digital firms (e.g., Hufbauer and Lu, 2018). In our sample, approximately 40 percent of the firms are headquartered in the U.S. and 24 percent in the EU at the time of the proposal.

Table 32: Descriptive statistics

Variable	N	Mean	SD	P25	Median	P75	Min	Max
Stock return	53,724	0.08	1.65	-0.72	0	0.87	-5.14	5.62
Market return (S&P 1200)	53,724	0.05	0.57	-0.15	0.07	0.33	-4.07	1.61
ETR	42,350	25.63	12.29	18.37	25.62	31.66	0.06	85.71
Intangible to total assets	53,482	31.67	23.97	9.05	29	49.96	0	89.46
EU revenue/total revenue	50,820	46.25	39.05	1.54	46.71	85.15	0	100
Revenues in billion euro	53,724	6.15	14.6	1.32	2.35	5.1	0.66	148.31
Loss-making (last year)	53,724	0.09	0.29	0	0	0	0	1
Revenue growth (last year)	52,514	0.17	1.11	-0.07	0.01	0.12	-0.54	12.26
Asset growth (last year)	52,514	0.1	0.64	-0.06	0.01	0.11	-0.39	8.59

Notes: Treated firms are listed firms with consolidated annual turnover above 750 million euros that are classified to be affected by the digital tax proposals. All values, except for the number of firms *N*, *loss-making (last year)* and *Revenues in billion euro*, are stated in percent.

R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal (group of treated firms). R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to one in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally weighted portfolio of all 222 treated firms, and β is the estimate of the portfolio's market beta.[69] The coefficient γ provides an estimate for the average abnormal return during the event window. This coefficient has to be multiplied by the number of days in the event window to obtain an estimate for the cumulative average abnormal return (CAAR) (Doidge and Dyck, 2015; Eckbo et al., 2007).[70]

For our cross-sectional analyses (*H2* and *H3*), we include a parameter to account for a firm's level of tax avoidance, profit shifting potential or other firm-specific characteristics, which we obtain from the ORBIS database. The conditional market model expands as follows:

$$R_{it} = \alpha + \beta R_{mt} + \gamma D_t + \rho I_i + \delta I_i D_t + e_{it}. \quad (13)$$

The variables are defined as before, and I_i is an indicator for firm-specific characteristics. The estimate of the interaction coefficient, δ, becomes the coefficient of interest.

[69] We would obtain similar results, if we use the return of an equally weighted portfolio of all affected firms as the dependent variable ($R_{pt} = \alpha_p + \beta_p R_{mt} + \gamma D_t + e_{pt}$), where the subscript p stands for the portfolio (Frischmann et al., 2008). However, our setting allows us to extend our model by including firm specific characteristics, as depicted in equation (13).

[70] Equivalently, computing a regression for each individual firm ($R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i D_t + e_{it}$) and taking the coefficients' averages would lead to similar results (Kothari and Warner, 2007). We describe this analysis in Appendix 39.

5.4. Results

5.4.1. Main Results

The baseline results of the event study are presented in Table 33. In the event period of interest, we find a mean negative CAAR of -0.692 percent, which is significant at the one percent level. The analysis provides significant statistical evidence of a mean negative stock price reaction of affected firms to EU digital tax proposals relative to the market (S&P Global 1200).[71] This result confirms our first hypothesis. Assuming efficiency of capital markets, this mean negative change in firm values around the event date represents both the expected costs and profits of the event as well as the ex ante probability that the event occurs, i.e., the net present value that is associated with the proposals (Johannesen and Larsen, 2016; Wagner et al., 2018a). Our result is consistent with investors expecting an increased likelihood of the introduction of digital taxes, which constitute negative news for digital firms' future profitability. Moreover, the result

Table 33: Cumulative average abnormal return – baseline result

	(1) Stock return
Alpha	0.044**
	(0.019)
Market return (S&P 1200)	0.715***
	(0.048)
21-22 Mar. 2018	-0.692***
	(0.070)
Observations	53,724
Firms	222
Adj.-R2	0.063

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 222 treated firms and β is the estimate of the portfolio's market beta. The coefficient estimate of γ (and the corresponding standard error) is multiplied by two to account for the length of the two-day event window (Eckbo et al. 2007). γ can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the two-day event window. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

[71] We replicate our analysis employing the Fama-French three-factor model and the model used by Kothari and Warner (2007) and obtain similar results. See Appendix 39 and Appendix 40. Furthermore, our results remain similar if we use a value-weighted portfolio instead of an equally weighted portfolio (Appendix 41). Finally, to mitigate concerns with the statistical significance of the results, we employ additional parametric and non-parametric significance tests (Appendix 42).

indicates that the capital market expects some part of the tax incidence to lie with shareholders. This implies that investors believe that the additional expenses cannot be fully passed through to consumers or labor and that the demand for digital services is not perfectly inelastic.[72]

To further understand the investor reaction, we test our second hypothesis by analyzing the market reaction with regard to firms' tax avoidance activities. We interact our event date dummy with different measures of tax avoidance. We define the variable *Tax avoidance* as the negative of the effective tax rate (ETR). Based on financial statement information, we calculate a one-year short-term and a five-year long-run ETR measure for all potentially affected firms (Dyreng et al., 2008). The one-year short-term ETR measure is based on the most recent financial statement information that is at hand for investors on the event date. The five-year measure is based on the annual statements from 2013 to 2017. In line with Dutt, Ludwig et al. (2019), we assume that firms with lower ETRs engage more actively in tax planning and tax avoidance. In addition, we define the variable *Profit shifting potential* as the ratio of intangible assets to total assets. Various studies show that intangible assets, and implicitly the level of research and development activities, are positively associated with engagement in profit shifting (De Simone et al., 2016; Griffith et al., 2014; Heckemeyer et al., 2014).

Table 34 depicts the results. As expected, the regression results in column (1) show that the capital market reaction is more pronounced for firms that avoid more taxes. A firm with an ETR of 25.63 percent (the average in our sample) has a negative stock market reaction in our event window of 0.679 percent and a one percentage point decrease in the ETR is associated with a 0.021 percentage point lower two-day CAAR. We find similar results if we use the long-run ETR measure to proxy tax avoidance (column 2). Furthermore, stock prices seem to decrease more for firms with a higher profit shifting potential, albeit not significantly in

[72] We acknowledge that a clear-cut distinction between the effects of the two directives is unfeasible as they were released at the same time. However, in contrast to the proposal on a significant digital presence, the precise and detailed proposal on the DST allows investors to perceive a direct analysis of the effect of the potential new legislation on profits.

Table 34: Cross-sectional analysis – tax avoidance

	(1) Stock return	(2) Stock return	(3) Stock return
Alpha	0.047**	0.047**	0.044**
	(0.020)	(0.020)	(0.019)
Market return (S&P 1200)	0.676***	0.676***	0.714***
	(0.050)	(0.050)	(0.048)
21-22 Mar. 2018	-0.679***	-0.727***	-0.692***
	(0.166)	(0.154)	(0.078)
Tax avoidance	0.001		
	(0.001)		
Tax avoidance x 21-22 Mar. 2018	-0.021***		
	(0.006)		
Tax avoidance (5-year)		0.000	
		(0.001)	
Tax avoidance (5-year) x 21-22 Mar. 2018		-0.022**	
		(0.010)	
Intangible to total assets			-0.001
			(0.001)
Intangible to total assets x 21-22 Mar. 2018			-0.009
			(0.010)
Observations	42,350	42,350	53,482
Firms	175	175	221
Adj.-R2	0.060	0.060	0.062

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + \rho_i TAX_i + \delta_i TAX_i D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*, D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. TAX_i is an estimate for the tax avoidance or the profit shifting potential of a firm. In the first column, *Tax avoidance* is measured as the negative of a firm's effective tax rate (ETR). The second column uses the five-year long-run ETR measure. In both specifications, firms with negative ETRs are excluded from the sample. The negative conversion allows for an intuitive interpretation of the coefficient δ_i on the two-day *CAAR*. The *Tax avoidance* variable is centered on the mean. In the third column, *Profit shifting potential* is measured as the ratio of intangible to total assets. Coefficients can be interpreted as in Table 33. In addition, ρ_i measures the effect of the firm-specific indicator on the stock return, respectively. δ_i is an estimate of the effect of the firm-specific indicator on the two-day *CAAR*. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

conventional terms (column 3). Overall, the results are in line with our second hypothesis. The findings indicate that investors pay a premium for the shares of tax-avoiding digital firms and that investors believe that the proposed measures will hamper tax avoidance, increasing affected firms' effective tax burdens to similar levels as those of less tax-avoiding firms.[73] Hence, the price premium for tax-avoiding firms diminishes upon the proposals' release, which is in line

[73] Note that due to the deductibility of the DST from the corporate income tax base, those firms that currently pay more corporate income tax will be able to deduct more of the DST paid. Assuming that firms are unable to avoid the DST since it is a tax on revenues and, thus, pay taxes in proportion to their digital revenues in the EU, the effective tax burdens of affected firms will converge.

with the European Commission's intention to safeguard tax revenues from base erosion and profit shifting.

Next, we test our third hypothesis to evaluate whether investors perceive the digital tax as effective in extracting location-specific rent from digital firms. Since exact information about the amount of user value creation is not observable and the extent of firms' digital activity, digital revenues or number of users in a country is not disclosed publicly, it is difficult for investors to assess precisely to what extent a firm is affected by digital tax proposals. For this reason, investors may instead evaluate a firm's engagement in the European market. We assume that the level of engagement in the European market is positively correlated with the level of revenues that are recognized in the financial statements of European affiliates of multinational groups. We define the variable *EU exposure* as the ratio of EU affiliates' revenues to the total revenue of the group's affiliates. The higher the ratio, the more a group is engaged in the European market. Table 35 depicts the results of the regressions that include firm-specific interaction variables. Column (1) highlights that higher EU exposure has a significant negative effect on the two-day CAAR. This result indicates that investor reaction is in line with the scope of the proposals that are limited to digital services provided in the EU. This analysis also corroborates our assumption that investors mainly reacted to the DST proposal. The DST is an additional tax in the European market, regardless of whether a taxable nexus already exists. In contrast, the virtual permanent establishment proposal is designed to create a new nexus for firms that thus far do not have a taxable nexus, i.e., EU affiliates, but engage in significant digital activities in the EU. Thus, if investors had reacted rather to the significant digital presence proposal, we should have observed no or a positive association between EU exposure and stock prices.

Column (2) indicates that, as intuitively expected, investor reaction is more negative for firms with higher revenues. Our data do not allow us to disentangle digital services revenues and non-digital revenues, but we assume that digital revenues are proportional to overall

Table 35: Cross-sectional variation – firm-specific characteristics

	(1) Stock return	(2) Stock return	(3) Stock return
Alpha	0.043**	0.043**	0.043**
	(0.019)	(0.020)	(0.019)
Market return (S&P 1200)	0.703***	0.715***	0.715***
	(0.048)	(0.048)	(0.048)
21-22 Mar. 2018	-0.621***	-0.668***	-0.619***
	(0.112)	(0.080)	(0.188)
EU exposure	0.000		
	(0.000)		
EU exposure x 21-22 Mar. 2018	-0.012**		
	(0.006)		
Revenues		0.000	
		(0.000)	
Revenues x 21-22 Mar. 2018		-0.012**	
		(0.005)	
Loss-making (2017)=1			0.015
			(0.039)
Loss-making (2017)=1 x 21-22 Mar. 2018			-0.770
			(1.348)
Observations	50,820	53,724	53,724
Firms	210	222	222
Adj.-R2	0.063	0.063	0.063

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + \rho_i I_i + \delta_i I_i D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*, D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. I_i is an indicator for firm-specific characteristics. First, *EU exposure* is measured as the ratio of revenues by subsidiaries located in the EU to the overall revenue of all the firm's subsidiaries. Second, *Revenues* measure a firm's consolidated revenues. The variable is centered on the mean. Third, *Loss-making* is a dummy variable indicating firms with losses in the financial year 2017. Coefficients can be interpreted as in Table 33. In addition, ρ_i measures the effect of the firm-specific indicator on the stock return, respectively. δ_i is an estimate of the effect of the firm-specific indicator on the two-day *CAAR*. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

revenues of digital firms. The capital market seems to have incorporated the effects of a flat gross revenue tax that increases the tax burden proportional to the level of turnover. The last column of Table 35 indicates that the reduction in stock prices is higher for corporations that have suffered a loss in the preceding financial year, although the interaction coefficient is not significant in traditional terms.[74]

[74] The small fraction of loss-making firms in our sample (only 20 firms with negative earnings before income and tax in 2017) limits the statistical power of this analysis.

Furthermore, we analyze whether investors perceive the proposals as a threat to future growth rates. Given that future growth perspectives are based on investors' expectations and are uncertain, we use the revenue growth and total asset growth of past years as a predictor for future growth. Table 36 depicts the results. The first (second) column shows that the two-day CAAR is more negative for firms that experienced larger (mean) revenue growth rates one year (over five years) before the release of the proposals. The effect on the two-day CAAR is similar for firms' total assets growth rate, as depicted in columns three and four. Investors seem to devalue firms with higher growth rates preceding the proposals' release more than firms with

Table 36: Cross-sectional variation – growth ratios

	(1) Stock return	(2) Stock return	(3) Stock return	(4) Stock return
Alpha	0.045**	0.045**	0.045**	0.045**
	(0.020)	(0.020)	(0.020)	(0.020)
Market return (S&P 1200)	0.720***	0.720***	0.720***	0.720***
	(0.049)	(0.049)	(0.049)	(0.049)
21-22 Mar. 2018	-0.720***	-0.718***	-0.720***	-0.718***
	(0.073)	(0.082)	(0.075)	(0.083)
Revenue growth (last year)	0.000**			
	(0.000)			
Revenue growth (last year) x 21-22 Mar. 2018	-0.004***			
	(0.001)			
Revenue growth (5-year)		0.000**		
		(0.000)		
Revenue growth (5-year) x 21-22 Mar. 2018		-0.009***		
		(0.003)		
Asset growth (last year)			0.000**	
			(0.000)	
Asset growth (last year) x 21-22 Mar. 2018			-0.010***	
			(0.002)	
Asset growth (5-year)				0.000
				(0.000)
Asset growth (5-year) x 21-22 Mar. 2018				-0.005**
				(0.002)
Observations	52,514	52,514	52,514	52,514
Firms	217	217	217	217
Adj.-R2	0.063	0.063	0.063	0.063

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + \rho_i I_i + \delta_i I_i D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*, D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. I_i is an indicator for firm-specific growth ratios. Column (1) includes the revenue growth rate of 2016 to 2017, i.e., the year preceding the release of the proposals. Column (2) includes the five-year average revenue growth rate for the years 2013 to 2017. Column (3) includes the total assets growth rate of 2016 to 2017. Column (4) includes the five-year average total assets growth rate for the years 2013 to 2017. The growth rates are centered on the mean. Coefficients can be interpreted as in Table 33 and Table 35. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

lower growth rates. This result indicates that investors perceive proposals to mitigate the future growth potential of digital firms.

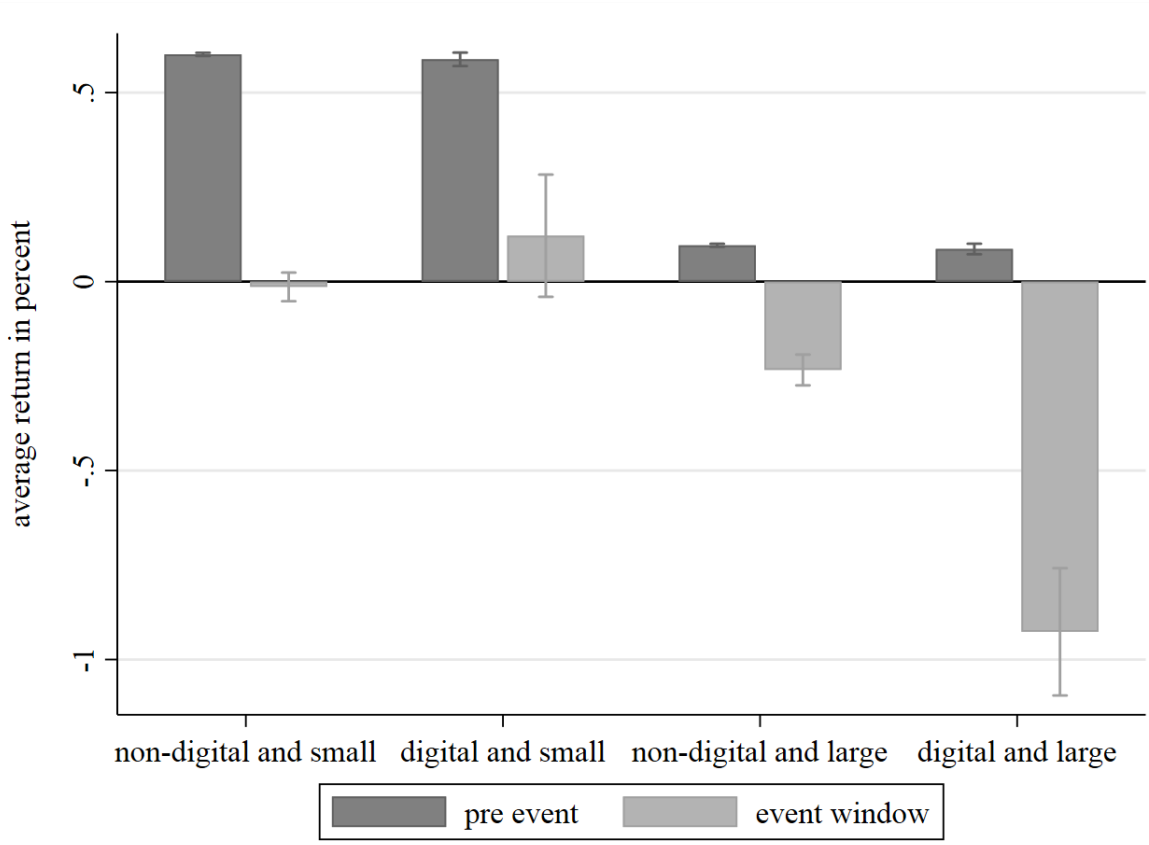
Overall, the findings imply that the market differentiates its response depending on firm characteristics when evaluating the effect of the "digital tax package". The cross-sectional results suggest that investors incorporate the intention of the European Commission's proposals to secure tax revenues and extract location-specific rent in their reaction.

5.4.2. Additional Analyses

In this section, we apply two additional analyses to corroborate our main result. First, we directly leverage all listed firms' returns – affected and not affected by the EU proposal. For this reason, we obtain stock market data on all actively traded firms in the countries of our initial sample, i.e., all countries from which the treated digital firms are coming. Our extended sample consists of 17,370 firms, which can be grouped into four categories. The first category comprises 13,360 non-digital and small firms (revenue below 750 million euros). The second category comprises 767 digital and small firms. The third category consists of 3,021 non-digital and large firms. Finally, we have – as in our initial sample – 222 digital and large firms.

We begin by demonstrating the descriptive differences in average returns for each group before and within the event window. Figure 18 depicts the coefficients graphically. For each group, the figure shows that the average return in the event window is below the pre-event period but that for digital and large firms, the average return is the most negative and is significantly different from zero in the event window. The strong negative investor reaction in contrast to the other groups validates that the reaction can be tied to the release of digital tax proposals.

Figure 18: Comparison of affected and unaffected firms by size and industry



Notes: The graphic depicts the average returns of four different groups of firms over 250 trading days before the event date, excluding the ten trading days immediately prior to the event date and within the two-day event window from March 21 to March 22, 2018. 13,360 firms are non-digital and small (revenue below 750 million Euro), 767 firms are digital and small, 3,021 firms are non-digital and large and 222 firms are digital and large. The vertical lines represent the 95 percent confidence intervals.

Furthermore, we use this extended sample to apply an alternative empirical approach and re-estimate the event study using the following empirical design:

$$R_{it} = \alpha + \beta_1 Large_i + \beta_2 Digital_i + \beta_3 Event_t + \beta_4 Large_i * Digital_i + \beta_5 Large_i * Event_t + \beta_6 Digital_i * Event_t + \beta_7 Large_i * Digital_i * Event_t + e_{it}. \quad (14)$$

R_{it} is, as in our main specification, the return of firm i on day t. $Large_i$ is a dummy variable that identifies firms above the revenue threshold of 750 million euros. $Digital_i$ is a dummy variable that identifies all firms that are part of the digital economy.[75] $Event_t$ is a dummy variable that takes the value of one in the event window. The coefficient of the triple interaction,

[75] As in the initial specification, the relevant NACE Rev. 2 codes are: 6201, 6209, 6311, 6312, 4791 and 5811 to 5819.

β_7, is our coefficient of interest and indicates whether the return of large and digital firms, those affected by the proposals, is different in the event window relative to non-affected firms. While in the main analysis the abnormal return is estimated as the return's deviation from the expected return using a firm's alpha, beta, and the general market movement, in this analysis, we estimate the abnormal return of affected firms relative to non-affected firms. We find a negative and statistically significant average abnormal return of -0.832 percent of large and digital corporations in the two-day event window relative to the groups of non-affected firms.[76] Hence, we find a qualitatively similar result to our main specification.

Second, we exploit the fact that many European countries started introducing a DST unilaterally, as no consensus at the EU level had been reached. Among others, France passed a DST in July 2019, which applies retroactively as of January 1, 2019. We exploit this legislation to analyze how investors react to the actual passing of a DST policy. Due to the ongoing debate in the EU and France, investors knew well before the bill passed the French Senate on July 11, 2019 that digital firms might be subject to an additional tax. Hence, it is feasible that we do not observe any market reaction since the effect was already incorporated into market prices. However, the French DST introduction was subject to significant public attention and political pressure by the U.S. government (New York Times, 2019; U.S. Trade Representative, 2019; WSJ, 2019). Hence, investors could also believe that an introduction is unlikely due to the threat of a costly U.S. intervention. Notwithstanding the U.S. government's pressure, the French Senate voted in favor of a DST, which is widely based on the European Commission's proposal. An impact assessment before the introduction identifies 23 listed digital MNEs to be affected (Pellefigue, 2019). We find a significant negative CAAR for these firms of -0.28 percent and

[76] The results are depicted in Appendix 43. Inferring that the average abnormal return in the event window is attributable to the news about digital taxes rather than to general trends between groups is contingent on the assumption that affected and non-affected firms share parallel trends in the pre-event period. Appendix 44 confirms that the stock market movement is not systematically different between affected and non-affected firms in the pre-event period.

depict the analysis in Table 37.[77] Exploiting this setting is particularly valuable since it shows investors' reaction to the actual enactment of a DST. Finding a negative reaction at the actual policy passing, and in addition to the reaction to the European Commission's proposal release, supports our suggestion that investors perceive the effect of digital taxes to be highly negative and extends our previous findings.

5.4.3. Economic Magnitude

Based on our findings of a negative capital market reaction, we estimate the market value reduction in absolute terms. Market values are obtained from the EIKON database and converted into euros using the applicable exchange rate on our event date. The total market value of all 222 affected firms is more than four trillion euros. We estimate the firm-specific change in abnormal market value as the product of a firm's market value and the firm-specific abnormal return in our two-day event window (Cline et al., 2018; Malatesta, 1983; Peterson, 1989).[78] The overall abnormal market value change is the sum of all affected firms' abnormal

Table 37: Analysis of French enactment of the digital services tax

	Stock return
Alpha	0.044
	(0.044)
Market return (S&P 1200)	1.105***
	(0.129)
11-12 Jul. 2019	-0.282***
	(0.069)
Observations	1,679
Firms	23
Adj.-R2	0.164

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the French digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 23 treated firms and β is the estimate of the portfolio's market beta. The coefficient estimate of γ (and the corresponding standard error) is multiplied by two to account for the length of the two-day event window (Eckbo et al. 2007). γ can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the two-day event window. The model is estimated using returns of 82 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

[77] We limit the estimation period in this analysis to the months between the final rejection of the DST on an EU-wide level to avoid any confounding events during our pre-event period.

[78] We estimate $\Delta MV = \sum_{i=1}^{222} \sum_{t=0}^{1} MV_{it} \times AR_{it+1}$, where MV_{it} refers to the closing market value of firm i at trading day t. AR denotes the abnormal return. $t = 0$ refers to March 20, 2018. The firm-specific AR is estimated using

market value changes. We find that the market value of firms that are likely to be affected by EU digital tax proposals dropped by 52.854 billion euros in excess of the normal market movement. A considerable share of the abnormal market value change was born by U.S.-based firms, which constitute the largest group of treated firms. In numbers, approximately 40 percent of the market value reduction is attributable to firms headquartered in the U.S.

Intuitively, the economically significant abnormal change in market value stands in contrast to the annual tax revenue estimates generated from the DST of 3.9 to 5 billion euros (European Commission, 2018c; Fuest et al., 2018). We translate the annual tax revenue estimates in present value figures to compare them to the market value reduction. Unfortunately, we cannot directly observe a firm's digital revenue generated in the European Union to directly compare market value changes to tax payments at the firm level. In a back-of-the-envelope calculation, we proxy the aggregated present value (PV) of the estimated tax revenues to find the breakeven point of the reduction in shareholder wealth and the increase in social wealth.[79] We graphically depict the PV of the estimated annual tax revenues in Appendix 45. For example, if we assume five billion euros of annual tax revenues, which the European Commission expects to increase by 20 percent per annum and the current zero-interest rate environment as discount rate for the PV calculation, it will take approximately six years to recover the initial drop in market value with tax revenue. Altering the assumptions, it will take 7 or 11 years. We acknowledge that both figures are not precisely comparable since the deadweight loss and the economic incidence of the newly proposed tax are unclear and tax revenues might develop differently and certainly non-linearly over time.

the method by Kothari and Warner (2007), see Appendix 39 for an explanation. We do this because multiplying our result of the CAAR from the regression analysis with the market value of the treated firms would lead to slightly different results, as the CAAR in our baseline regression is drawn from an equally weighted portfolio.

[79] We estimate a model of the following form: $PV_0 = TaxRevenue_0 \times \sum_{t=1}^{T} \frac{(1+g)^t}{(1+r)^t}$, where g refers to the expected annual growth rate of tax revenue per year t and r to the discount rate.

5.4.4. Additional Robustness Tests

We conduct additional tests to verify the robustness of our main results. In Appendix 46, we replicate our main analysis for four alternative event dates to mitigate concerns that the event has materialized at different points in time.[80] We test the market reaction on first, dates before the release of the proposals, on which some rumors about a new European DST spread publicly; and second, dates after the release of the proposals on which it became more certain that an EU-wide political agreement on the DST will not be reached. All results are indistinguishable from zero. Except on March 12, 2019, the abnormal return estimates are significantly negative. This finding is counterintuitive, as the date marks the time when it became more certain that the EU would not enact a common DST in the near future. However, several economy-wide shocks regarding the ongoing debate about the exit of Great Britain from the EU hit the market on the same date. Although we cannot entirely exclude that the capital market had already incorporated some rumors on the digital tax proposals gradually, our event study analysis of the additional event dates gives us confidence that investors reacted to the "digital tax package" primarily on the date of the official proposal, March 21, 2018.

Next, we address concerns that news regarding a trade war could have triggered the market reaction. If the firms affected by the digital tax proposals had reacted to the increased probability of a trade war, investors would presumably also react similarly on other dates of the heightened probability of a trade war. Hence, we test the market reaction on dates with heightened media attention on a potential trade war. Conducting a Google Trends analysis, we find that on at least four dates in 2018, the term 'trade war' received great attention. We replicate the event study analysis for these dates and depict the results in Appendix 47. Overall,

[80] On February 26, 2018 the first rumors on a potential digital tax initiative by the European Commission were spread. On March 15, 2018 occasional reports on the soon to be released directive proposals can be found (Becker and Englisch, 2018; Bloomberg, 2018; Financial Times, 2018a). At the Economic and Financial Affairs Councils on December 04, 2018 a strong opposition against the proposals was formed and on March 12, 2019 the EU Digital Services Tax proposal was finally taken off the agenda in an official debate.

we cannot see a significant negative capital market reaction on one of the alternative dates that heightened the risk for a (tax-)trade war.

Finally, we analyze the dates surrounding our event window to mitigate concerns that other events close to our event window confound our findings. In Appendix 48, we show the abnormal buy and hold return for the portfolio of treated digital firms. That is, we display the abnormal value development of a portfolio that is bought one trading day before the event window and held until after the event window. We confirm that a significant negative abnormal return drop is observable only during our event window and that this drop does not revert over the subsequent days. Next, we quantitatively disentangle the dates surrounding the event. Appendix 49 shows the results. The daily abnormal returns range between -0.380 and 0.167 percent.[81] The positive abnormal return on the date before our event window indicates no stock market anticipation of the proposals' release. In line with this result, we find a smaller CAAR if we extend our event window length to a three-day window. This confirms the event window choice based on Google Trends analysis and media search.

5.5. Conclusion

The era of digitalization has led to an intense political and academic debate on how to adapt the principles of corporate taxation to the digital economy. However, empirical evidence on the effects of proposed adjustments to corporate taxation is scarce. Our study contributes to the recent call for further research on the proposed policies of taxing the digital economy and helps to evaluate the effects of digital tax measures.

We examine the European Commission's "digital tax package" on the taxation of the digital economy published on March 21, 2018. The "digital tax package" proposes both the introduction of a three percent DST on gross revenues from digital services and a reform of where to tax digital profits. Analyzing the capital market reaction in response to the proposals'

[81] In an untabulated analysis, we also confirm that our results are not biased by a small number of sizeable negative abnormal returns. Of the 222 affected firms, 144 firms have negative abnormal returns in our event window.

release, we find a significant reduction in the firm value of 222 digital firms, which are likely to be affected. The negative abnormal market reaction of -0.692 percent translates to a market value decrease of digital corporations by at least 52 billion euros, 40 percent of which is attributable to U.S.-based corporations. Our main result has three central implications: first, it suggests that investors, on average, perceive the increased likelihood of the introduction of digital tax measures as negative for firms' future profitability and investors do not anticipate that firms are able to easily avoid the additional tax; second, our evidence implies that investors expect that firms will not be able to pass through all of the additional tax expenses to labor or customers; third, the economic magnitude of the reaction implies that the capital market does not expect these tax measures to be repealed in the short term.

Our cross-sectional analyses reveal that the market differentiates its response depending on firm characteristics. We find that the negative abnormal return is significantly stronger for firms that are more tax-avoiding and for firms that have higher profit shifting potential. This result suggests that firms receive a market premium for tax avoidance and that the premium diminishes with the proposed tax measures.

Overall, the investor reaction reflects the intention of the European Commission's proposals to secure tax revenues and extract location-specific rent, suggesting that the capital market expects that the proposals' objectives are achievable. However, our results indicate that increasing the tax burden for a highly innovative industry contradicts political initiatives to promote an attractive investment climate and interferes with the EU's core objective to foster innovation and economic growth.

6. Summary

(1) This dissertation addresses three central questions. First, how large is the extent of base erosion and profit shifting and how has BEPS evolved? Second, to what extent has the digital transformation corroborated the ability of multinational corporations to engage in cross-border income shifting? Third, how do key stakeholders of multinational firms evaluate reform proposals to safeguard tax revenues and to counteract BEPS?

(2) Addressing the first question of this dissertation provides valuable insights into policymakers' concerns of decreasing corporate income tax revenues. The ongoing academic and political debate still lacks convincing and updated measures of the extent of profit shifting and the assessment of its economic relevance. Simplified indicators, as proposed by the OECD in the Final Report on BEPS Action 11, provide only limited information on the extent of BEPS. Nevertheless, it is of utmost importance to provide transparent updates on the existence and extent of BEPS for the ongoing public, political and academic debates. Insights gained from well-specified empirical analyses that apply convincing identification strategies based on granular data help develop a holistic view of BEPS and evaluate ongoing proposals to reform the global corporate income tax system.

(3) Analyzing the effect of firms' investment in digitalization on tax-induced income shifting addresses the second question of this dissertation. It can be expected that firms with a higher level of digitalization engage more actively in tax-induced income shifting to maximize after-tax returns. A novel, micro-level digitalization index based on a survey monitoring European firms' digital technology usage captures firms' investment in digitalization. The analysis in section 3 provides evidence on tax-induced income shifting only for digitalized firms. Disentangling the elements that comprise the digitalization index reveals that communication and coordination between different parts of a firm seem to be a key enabler of multinational's tax planning strategies. Overall, the results imply that digitalization is a

crucial foundation for timely, data-driven decision making that extends beyond core business functions to support functions such as the tax department.

(4) Two studies address the third central question of this dissertation. First, the relatively surprising political decision, in February 2013, to adopt a public country-by-country reporting requirement for European financial institutions has not affected the firm values of financial institutions headquartered in the EU. Disentangling the sample of affected financial institutions reveals a negative reaction of banks with attractive income shifting opportunities and higher reputational risks. The positive stock market reaction of banks with information asymmetries between managers and shareholders highlights the expected advantages that stem from the new reporting requirement. Evaluating the expectation that goes along with this specific country-by-country reporting requirement provides valuable insights for policymakers deciding upon implementing additional tax disclosure rules.

(5) Second, in March 2018, the European Commission proposed two draft directives on the taxation of the digital economy. The first draft directive suggests introducing an interim tax of three percent on gross revenues from certain digital services. The second draft directive lays down the rules for taxing corporate profits attributable to a significant digital presence. Analyzing the stock returns of potentially affected firms surrounding the draft directives' release reveals a significant abnormal capital market reaction at the time of the proposal. Cross-sectional analyses reveal that the negative abnormal return is significantly stronger for firms that avoid taxes more and have higher profit shifting potential than others. Overall, the investor reaction reflects the intention of the European Commission's proposals to secure tax revenues and extract location-specific rent, suggesting that the capital market expects that the proposals' objectives are achievable.

(6) In a nutshell, the self-contained sections provide answers to the three central questions that this dissertation raises. First, it is still a pressing issue to develop convincing and easy to interpret measures to estimate the extent of BEPS. Simplistic indicators provide only limited

evidence for BEPS. Policy decisions should be based on empirical studies that exploit well-specified identification strategies and granular data. Second, the rapid digital transformation can contribute to the ability of multinational firms to engage more actively in income shifting activities. Digital infrastructure, especially facilitators of communication, seems to be a crucial foundation for timely, data-driven decision making in tax departments of multinational firms. Third, investors react to the introduction and proposal of legal measures to increase tax transparency and to safeguard tax revenues. Firms that engage more in income shifting activities and that pay fewer taxes experience larger price drops. This finding implies that investors react to the intentions of political reforms.

LITERATURE

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APPENDIX

A. Appendix to Section 2

Appendix 1: Indicator 4 - yearly estimates

Variable	(1)	(2)	(3)	(4)
2000:Large	-0.7736*	-1.0850***	-1.5108***	-2.2380***
	(0.3954)	(0.3939)	(0.4585)	(0.4781)
2001:Large	0.3147	-0.1126	-0.5575	-1.5111***
	(0.3462)	(0.3458)	(0.4338)	(0.4350)
2002:Large	2.1868***	2.0076***	0.9700***	-0.5627
	(0.2877)	(0.2872)	(0.3543)	(0.3896)
2003:Large	1.9998***	1.7776***	1.1361***	0.2366
	(0.2496)	(0.2487)	(0.3303)	(0.3794)
2004:Large	2.4646***	2.3151***	1.6728***	0.8735**
	(0.2148)	(0.2143)	(0.3107)	(0.3476)
2005:Large	1.6306***	1.4252***	0.6555**	-0.1470
	(0.2075)	(0.2087)	(0.2853)	(0.3082)
2006:Large	1.7789***	1.4896***	0.0942	-0.4781*
	(0.1828)	(0.1835)	(0.2573)	(0.2764)
2007:Large	0.7786***	0.3788**	-0.7637***	-1.3707***
	(0.1840)	(0.1859)	(0.2478)	(0.2505)
2008:Large	1.0072***	0.6677***	0.1081	-0.9128***
	(0.1883)	(0.1897)	(0.2579)	(0.2527)
2009:Large	0.3695*	0.1497	-0.5623**	-1.3280***
	(0.1894)	(0.1901)	(0.2498)	(0.2600)
2010:Large	0.2563	0.0688	-0.2922	-1.0931***
	(0.1759)	(0.1767)	(0.2338)	(0.2493)
2011:Large	1.3874***	1.1905***	0.8417***	0.3256
	(0.1664)	(0.1671)	(0.2229)	(0.2426)
2012:Large	0.9766***	0.8262***	0.2858	-0.1289
	(0.1652)	(0.1659)	(0.2246)	(0.2493)
2013:Large	0.4664***	0.3126**	-0.1981	-1.0866***
	(0.1581)	(0.1591)	(0.2142)	(0.2350)
2014:Large	0.4995***	0.3621**	0.2058	-0.8728***
	(0.1556)	(0.1565)	(0.2110)	(0.2286)
2015:Large	-0.3790***	-0.4503***	-0.7946***	-1.7849***
	(0.1449)	(0.1463)	(0.1934)	(0.2139)
2016:Large	-0.6421***	-0.6898***	-1.0967***	-1.9308***
	(0.1468)	(0.1482)	(0.1963)	(0.2175)
2000:Large x MNE	-1.7451***	-1.5094***	-1.6024***	-1.3151**
	(0.4446)	(0.4435)	(0.4997)	(0.5462)
2001:Large x MNE	-2.0168***	-1.7351***	-1.6660***	-1.0466**
	(0.3979)	(0.3978)	(0.4783)	(0.4984)
2002:Large x MNE	-2.1409***	-1.9829***	-1.1959***	-1.0171**
	(0.3257)	(0.3253)	(0.3976)	(0.4454)
2003:Large x MNE	-1.2244***	-1.0260***	-1.0556***	-1.2429***
	(0.2988)	(0.2978)	(0.3723)	(0.4335)

2004:Large x MNE	-2.4361***	-2.2845***	-1.8052***	-1.6114***
	(0.2469)	(0.2463)	(0.3470)	(0.3947)
2005:Large x MNE	-1.5695***	-1.3694***	-1.0705***	-0.9054**
	(0.2423)	(0.2431)	(0.3185)	(0.3516)
2006:Large x MNE	-2.0878***	-1.8566***	-0.7579***	-0.7890**
	(0.2100)	(0.2101)	(0.2895)	(0.3176)
2007:Large x MNE	-0.9689***	-0.6266***	-0.3101	-0.0279
	(0.2208)	(0.2219)	(0.2812)	(0.2908)
2008:Large x MNE	-1.5318***	-1.2965***	-1.5250***	-0.8234***
	(0.2275)	(0.2279)	(0.2937)	(0.2941)
2009:Large x MNE	-0.8038***	-0.5968***	-0.2437	-0.2402
	(0.2269)	(0.2268)	(0.2890)	(0.3038)
2010:Large x MNE	-0.8344***	-0.5917***	-0.7783***	-0.7657***
	(0.2069)	(0.2069)	(0.2680)	(0.2868)
2011:Large x MNE	-1.1547***	-0.8956***	-1.0909***	-1.6932***
	(0.1966)	(0.1964)	(0.2576)	(0.2806)
2012:Large x MNE	-1.1871***	-0.9812***	-1.3222***	-1.6207***
	(0.1950)	(0.1949)	(0.2575)	(0.2894)
2013:Large x MNE	-0.5882***	-0.4110**	-0.5016**	-0.4745*
	(0.1872)	(0.1873)	(0.2463)	(0.2750)
2014:Large x MNE	-0.7135***	-0.5245***	-0.9343***	-0.6510**
	(0.1825)	(0.1826)	(0.2418)	(0.2673)
2015:Large x MNE	-0.3270*	-0.2036	-0.5201**	-0.0968
	(0.1705)	(0.1711)	(0.2225)	(0.2520)
2016:Large x MNE	-0.7032***	-0.5873***	-1.0718***	-0.6808***
	(0.1720)	(0.1724)	(0.2241)	(0.2530)
Profitability (EBIT/TOAS)		-23.4167***	-23.5781***	-26.1302***
		(0.0940)	(0.1250)	(0.1065)
log Total Assets (TOAS)		-0.2317***	-0.0433***	-0.3191***
		(0.0088)	(0.0102)	(0.0098)
Innovation (IFAS/TOAS)		-2.3973***	-2.3508***	-2.6047***
		(0.1010)	(0.1048)	(0.1057)
Position in Group (GUO=1)		-0.7448***	-0.5962***	-0.8345***
		(0.0300)	(0.0328)	(0.0337)
Country-Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x	x	x	x
Country Restriction	-	-	OECD	EU
R2 (within)	0.345	0.362	0.354	0.365
Number of firms	1,001,429	1,001,429	843,911	854,141
Observations	5,048,716	5,048,716	4,320,449	4,353,789

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the effective tax rate (ETR). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. The dummy variables of interest are interacted with a year dummy to provide annual estimates. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 2: Indicator 4 - robustness change of outcome variable

Variable	(1)
2000:Large x MNE	-0.0151
	(0.0597)
2001:Large x MNE	-0.1056**
	(0.0464)
2002:Large x MNE	-0.1709***
	(0.0361)
2003:Large x MNE	-0.0489
	(0.0328)
2004:Large x MNE	-0.1017***
	(0.0275)
2005:Large x MNE	-0.0553*
	(0.0297)
2006:Large x MNE	-0.1501***
	(0.0244)
2007:Large x MNE	-0.0983***
	(0.0258)
2008:Large x MNE	-0.1209***
	(0.0255)
2009:Large x MNE	-0.0399*
	(0.0221)
2010:Large x MNE	-0.0697***
	(0.0200)
2011:Large x MNE	-0.1158***
	(0.0198)
2012:Large x MNE	-0.1221***
	(0.0188)
2013:Large x MNE	-0.0537***
	(0.0179)
2014:Large x MNE	-0.0632***
	(0.0178)
2015:Large x MNE	-0.0483***
	(0.0173)
2016:Large x MNE	-0.0883***
	(0.0177)
Country-Year Fixed Effects	x
Industry Fixed Effects	x
Controls	x
R2 (within)	0.666
Number of firms	1,001,429
Observations	5,048,716

Notes: This table presents the regression results for OECD BEPS Indicator 4. The dependent variable is the ratio of tax payments to total assets (TOAS). Large is a dummy variable that is equal to one for all firms with more than 250 employees. MNE is a dummy variable that is equal to one for all firms that belong to a group with a least one cross-border relationship. For the sake of brevity, we do not display the coefficient estimates for the control variables: Profitability is the ratio of earnings before income and taxes (EBIT) to total assets (TOAS), innovation is the ratio of intangible fixed assets (IFAS) to total assets and position in group is a dummy variable that is equal to one for all headquarters. The dummy variables of interest are interacted with a year dummy to provide annual estimates. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

B. Appendix to Section 3

Appendix 3: Correlation matrix

Variable	1	2	3	4	5	6	7	8	9	10
1. Digitalization index	1.0000									
2. Log (PLBT)	0.0575***	1.0000								
3. Log (TFAS)	0.0928***	0.4348***	1.0000							
4. Log (STAF)	0.0956***	0.5624***	0.5469***	1.0000						
5. Log (Intangible Assets)	0.0356***	0.3483***	0.3106***	0.4324***	1.0000					
6. Log (GDP per Capita)	-0.0516***	0.0599***	-0.1270***	0.0981***	0.1132***	1.0000				
7. Log (GDP)	-0.0585***	0.0810***	0.0255***	0.1666***	0.0894***	0.2247***	1.0000			
8. Unemployment	0.0822***	-0.0670***	0.0166***	-0.0445***	0.0007	-0.3557***	0.0562***	1.0000		
9. C	-0.0327***	-0.0017	-0.0273***	0.0555***	0.0038	0.1729***	0.3708***	0.1829***	1.0000	
10. Return on Assets	-0.0136***	0.1425***	-0.0581***	-0.0039	-0.0499***	0.0197***	-0.0130***	-0.0426***	-0.0183***	1.0000

Notes: ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 4: Variable definition

Variable	Definition
Total Assets	Total assets on the unconsolidated financial statements of firm i in year t.
Return on Assets (RoA)	Pre-tax earnings for firm i in year t scaled by total assets for firm i in year t.
Log(EBIT)	Natural logarithm of earnings before interest and tax (EBIT) reported on the unconsolidated financial statements of firm i in year t.
Log(PLBT)	Natural logarithm of profit and loss before tax (PLBT) on the unconsolidated financial statements of firm i in year t.
Log(Tangible Assets)	Natural logarithm of tangible fixed assets (TFAS) on the unconsolidated financial statements of firm i in year t.
Log(Employee Compensation)	Natural logarithm of compensation expense (STAF) reported on the unconsolidated financial statements of firm i in year t.
Productivity (Prod)	The median return on assets measured on firm i's country-industry level in year t, where industry refers to the two-digit NACE classification.
C	Intra-group income shifting incentive of firm i in year t, measured as operating revenue-weighted average tax rate differential, of each firm to all other affiliates of a group, per year. $C_{it} = \frac{\sum_{k \neq i}^{n} OPRE_{kt} * (CIT_{it} - CIT_{kt})}{\sum_{k=1}^{n} OPRE_{kt}}$, where *i*, *k* and *n* are indicators for a firm, related affiliates and the total number of affiliates per group and year *t*, respectively.
Digitalization index (Digital)	Additive index ranging from 0 to 3 based on the usage of an enterprise resource planning (ERP) system, a database management system (DBMS) and groupware software of firm i in year t.
ERP / DBMS / Groupware	Dummy variable taking the value of one if an enterprise resource planning (ERP) system, a database management system (DBMS) or groupware software is available in firm i in year t and zero otherwise.
Distance to SAP	Distance to the nearest local SAP office measured in 1000 kilometers.
ERP introduction	Dummy variable taking the value of one for firms that implement an ERP system for the first time in 2009 or 2010 and zero for firms that never introduce any software solution.
ERP update	Dummy variable that takes the value of one for years as of 2009 and zero otherwise
Post	Dummy variable that takes the value of one in the periods after the shock to the income shifting incentive and zero otherwise.
Treat digital	Dummy variable that takes the value of one if a firm has a digitalization index level of 1 or higher and zero otherwise.
Log(Tax Fees)	Natural logarithm of tax fees paid of group j in year t for tax consultation services to the group's external auditor reported in the notes to the consolidated financial statements.
Country dispersion	The ratio of countries in which the group has affiliates over the group's total number of affiliates.
Accounting department	Dummy variable that takes the value of one if firms have a dedicated accounting department in year t.
Log(Intangible Assets)	Natural logarithm of intangible assets for firm i in year t.
Log(GDP per Capita)	Natural logarithm of the per-capita GDP of firm i's host country in year t.
Log(GDP)	Natural logarithm of the gross domestic product of firm i's host country in year t.
Unemployment	The unemployment rate of firm i's host country in year t.
CIT	The corporate income tax rate of firm i's host country in year t.

Notes: Variables used in section 3.6.3. are on the consolidated group level. Otherwise, the definitions remain the same.

Appendix 5: Alternative functional form of digitalization index

	Dependent Variable: Log(PLBT)			
	Dummy interaction		Categorical interaction	
Variable	(1)	(2)	(3)	(4)
C x Digital = 1	-0.889***	0.223	-1.049***	-0.179
	(0.336)	(0.566)	(0.347)	(0.399)
C x Digital = 2			-0.701**	-0.513
			(0.346)	(0.491)
C x Digital = 3			-1.259***	-0.398
			(0.414)	(0.616)
C	0.248	-0.341	0.293	0.232
	(0.329)	(0.517)	(0.320)	(0.448)
Digital = 2			0.009	-0.010
			(0.019)	(0.018)
Digital = 3			0.018	-0.002
			(0.014)	(0.016)
Log(Tangible Assets)	0.168***	0.013	0.171***	0.019
	(0.011)	(0.019)	(0.010)	(0.015)
Log(Employee Compensation)	0.659***	0.310***	0.638***	0.390***
	(0.019)	(0.053)	(0.017)	(0.045)
Productivity	2.911***	7.085***	3.900***	7.161***
	(0.626)	(0.791)	(0.558)	(0.601)
Log(GDP per Capita)	0.087*	-1.487	0.036	-1.228
	(0.048)	(1.238)	(0.044)	(0.852)
Log(GDP)	0.016	1.366	0.025*	1.264
	(0.015)	(1.163)	(0.014)	(0.814)
Unemployment	-0.016***	-0.026***	-0.016***	-0.024***
	(0.006)	(0.009)	(0.004)	(0.006)
Digital x Log(Tangible Assets)	-0.012	0.028	-0.008	0.009
	(0.012)	(0.021)	(0.005)	(0.008)
Digital x Log(Employee Compensation)	0.022	0.102*	0.025***	0.008
	(0.021)	(0.058)	(0.009)	(0.024)
Digital x Productivity	1.862***	1.839**	0.307	0.848***
	(0.665)	(0.846)	(0.269)	(0.294)
Digital x Log(GDP per Capita)	0.004	2.211*	0.029	0.751*
	(0.049)	(1.294)	(0.020)	(0.395)
Digital x Log(GDP)	-0.011	-2.451**	-0.010	-0.943**
	(0.016)	(1.216)	(0.006)	(0.380)
Digital x Unemployment	0.012**	0.011	0.005***	0.004
	(0.006)	(0.009)	(0.002)	(0.003)
Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x		x	
Firm Fixed Effects		x		x
Interaction of Fixed effects	Yes	Yes	Yes	Yes
Observations	144,796	141,949	144,796	141,949
Number of firms	24,715	21,868	24,715	21,868
R2 (within)	0.349	0.040	0.346	0.038

Notes: This table presents the regression results for the baseline approach for 144,796 firm-years of European affiliates of multinational corporations. C is the income shifting incentive measure as defined by Huizinga and Laeven (2008). The digitalization index (Digital) is determined as an additive index that captures if a firm has access to an ERP software, a database management system (DBMS) or groupware software. In the first two columns a value of one implies the firm has access to any of the software categories and in column three and four the index is treated as a categorical variable. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 6: Extrapolation of index and software categories to all affiliates

	Dependent Variable: Log(PLBT)			
Variable of Interest (VoI):	Digital	Groupware	DBMS	ERP
Variable	(1)	(2)	(3)	(4)
C x VoI	-0.160**	-0.244**	-0.273**	0.160
	(0.069)	(0.112)	(0.122)	(0.113)
C	-0.111	-0.208*	-0.186	-0.457***
	(0.142)	(0.107)	(0.113)	(0.091)
Groupware			-0.037***	-0.038***
			(0.011)	(0.008)
DBMS		0.063***		0.084***
		(0.010)		(0.008)
ERP		-0.010	0.018	
		(0.012)	(0.012)	
Log(Tangible Assets)	0.206***	0.198***	0.198***	0.197***
	(0.004)	(0.003)	(0.003)	(0.003)
Log(Employee Compensation)	0.581***	0.600***	0.592***	0.592***
	(0.006)	(0.005)	(0.005)	(0.004)
Productivity	3.562***	3.588***	3.624***	3.431***
	(0.277)	(0.217)	(0.223)	(0.182)
Log(GDP per Capita)	-0.012	0.003	-0.019	-0.005
	(0.016)	(0.012)	(0.012)	(0.010)
Log(GDP)	0.022***	0.024***	0.031***	0.044***
	(0.007)	(0.006)	(0.006)	(0.005)
Unemployment	-0.021***	-0.016***	-0.023***	-0.018***
	(0.002)	(0.002)	(0.002)	(0.001)
VoI x Groupware			-0.001	0.019
			(0.013)	(0.012)
VoI x DBMS		0.018		-0.022*
		(0.013)		(0.013)
VoI x ERP		0.017	-0.016	
		(0.014)	(0.013)	
VoI x Log(Tangible Assets)	-0.009***	-0.008**	-0.009***	-0.012***
	(0.002)	(0.003)	(0.003)	(0.003)
VoI x Log(Employee Compensation)	0.011***	-0.000	0.013**	0.021***
	(0.003)	(0.005)	(0.005)	(0.005)
VoI x Productivity	-0.009	0.003	-0.069	0.344
	(0.145)	(0.241)	(0.256)	(0.253)
VoI x Log(GDP per Capita)	0.007	-0.001	0.026*	0.012
	(0.008)	(0.012)	(0.013)	(0.012)
VoI x Log(GDP)	0.013***	0.025***	0.016***	-0.006
	(0.003)	(0.006)	(0.006)	(0.006)
VoI x Unemployment	0.002**	-0.001	0.009***	0.003
	(0.001)	(0.002)	(0.002)	(0.002)
Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x	x	x	x
Interaction of Fixed effects	Yes	Yes	Yes	Yes
Observations	802,243	802,243	802,243	802,243
Number of firms	24,715	24,715	21,868	24,715
R2 (within)	0.516	0.515	0.515	0.515

Notes: This table presents the regression results for the baseline approach. The digitalization index and the availability of the digital technology categories is extrapolated to all affiliates of a multinational. All remaining variables are specified as in Table 17. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 7: Country dispersion

	Dependent Variable: Log(PLBT)	
	Country dispersion	
Variable	(1)	(2)
C x Digital x Characteristic		-0.738*
		(0.378)
C x Characteristic	-0.638	
	(0.766)	
C	-0.111	-0.119
	(0.256)	(0.264)
Characteristic	-0.604***	
	(0.031)	
Digital		-0.002
		(0.007)
C x Digital		-0.074
		(0.145)
Log(Tangible Assets)	0.164***	0.158***
	(0.006)	(0.006)
Log(Employee Compensation)	0.655***	0.678***
	(0.011)	(0.011)
Productivity	4.472***	4.462***
	(0.340)	(0.343)
Log(GDP per Capita)	0.075***	0.089***
	(0.027)	(0.027)
Log(GDP)	-0.006	0.007
	(0.008)	(0.008)
Unemployment	-0.005**	-0.006***
	(0.002)	(0.002)
Year Fixed Effects	x	x
Industry Fixed Effects	x	x
Observations	144,796	144,796
Number of firms	24,715	24,715
R2 (within)	0.359	0.350

Notes: This table presents the regression results for the Huizinga and Leaven (2008) income-shifting model for 144,796 (142,945) firm-years of European affiliates of multinational corporations. Column one includes a measure for the country dispersion of firms. It is defined as the number of countries a firm is active in over the total affiliates of the group. In column two the firm-specific characteristic is interacted with a novel measure for the digitalization of firms (Digital). The digitalization index is determined as an additive index that captures if a firm has access to ERP software, a database management system (DBMS) or groupware software. It is based on a yearly survey over the period 2005 to 2016. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 8: Robustness I – non-interpolated digitalization index

	Dependent Variable: Log(PLBT)		
Variable	(1)	(2)	(3)
C x Digital	-0.193*		
	(0.115)		
C x Digital = 1		-1.118***	-0.768***
		(0.385)	(0.291)
C x Digital = 2		-0.526*	
		(0.319)	
C x Digital = 3		-0.881**	
		(0.355)	
C	-0.274	0.022	0.024
	(0.256)	(0.292)	(0.292)
Digital	0.003		
	(0.006)		
Digital = 1		-0.017	-0.001
		(0.021)	(0.017)
Digital = 2		0.005	
		(0.018)	
Digital = 3		0.000	
		(0.020)	
Log(Tangible Assets)	0.159***	0.159***	0.159***
	(0.006)	(0.006)	(0.006)
Log(Employee Compensation)	0.676***	0.676***	0.676***
	(0.011)	(0.011)	(0.011)
Productivity	4.559***	4.551***	4.552***
	(0.345)	(0.345)	(0.345)
Log(GDP per Capita)	0.100***	0.100***	0.100***
	(0.026)	(0.026)	(0.026)
Log(GDP)	0.004	0.004	0.004
	(0.008)	(0.008)	(0.008)
Unemployment	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)
Year Fixed Effects	x	x	x
Industry Fixed Effects	x	x	x
Observations	121,385	121,385	121,385
Number of firms	24,520	24,520	24,520
R2 (within)	0.351	0.351	0.351

Notes: This table presents the regression results for the Huizinga and Leaven (2008) income-shifting model for 121,385 firm-years of European affiliates of multinational corporations. It includes a novel measure for the digitalization of firms (Digital). The digitalization index is determined as an additive index that captures if a firm has access to ERP software, a database management system (DBMS) or groupware software. IT available is a dummy that indicates if a firm has access to any of the software categories. It is based on a yearly survey over the period 2005 to 2016. Index values are not interpolated over time in this table. The dependent variable is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Appendix 9: Robustness II – alternative control and dependent variables

	Controlling for intangibles		CIT as income shifting incentive		Log EBIT as dependent	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
C x Digital	-0.266**		-0.058		-0.141	
	(0.134)		(0.088)		(0.108)	
C x Digital = 1		-1.111***		-0.883***		-0.721**
		(0.399)		(0.255)		(0.315)
C x Digital = 2		-0.823**		-0.364		-0.381
		(0.372)		(0.241)		(0.295)
C x Digital = 3		-1.085***		-0.449*		-0.657**
		(0.412)		(0.273)		(0.331)
C	0.542*	0.895***	-1.180***	-0.829***	-0.264	-0.043
	(0.309)	(0.345)	(0.219)	(0.241)	(0.248)	(0.272)
Digital	-0.015**		0.015		-0.009	
	(0.007)		(0.028)		(0.006)	
Digital = 1		0.008		0.267***		0.005
		(0.020)		(0.081)		(0.016)
Digital = 2		-0.006		0.119		-0.003
		(0.020)		(0.077)		(0.016)
Digital = 3		-0.040*		0.133		-0.025
		(0.022)		(0.087)		(0.018)
Log(Intangible Assets)	0.054***	0.054***				
	(0.004)	(0.004)				
Log(Tangible Assets)	0.151***	0.151***	0.158***	0.158***	0.177***	0.177***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
Log(Employee Compensation)	0.683***	0.684***	0.681***	0.681***	0.685***	0.685***
	(0.014)	(0.014)	(0.011)	(0.011)	(0.010)	(0.010)
Productivity	5.174***	5.171***	3.705***	3.708***	4.922***	4.917***
	(0.375)	(0.375)	(0.342)	(0.342)	(0.311)	(0.311)
Log(GDP per Capita)	-0.013	-0.014	0.102***	0.102***	-0.041*	-0.042*
	(0.029)	(0.029)	(0.027)	(0.027)	(0.024)	(0.024)
Log(GDP)	-0.015	-0.015	0.037***	0.036***	0.003	0.003
	(0.009)	(0.009)	(0.010)	(0.010)	(0.008)	(0.008)
Unemployment	-0.008***	-0.008***	0.000	0.000	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year Fixed Effects	x	x	x	x	x	x
Industry Fixed Effects	x	x	x	x	x	x
Observations	108,738	108,738	149,279	149,279	145,611	145,611
Number of firms	19,838	19,838	25,151	25,151	24,616	24,616
R2 (within)	0.370	0.370	0.349	0.349	0.398	0.398

Notes: This table presents the regression results for the Huizinga and Leaven (2008) income-shifting model for European affiliates of multinational corporations. The first two columns control for intangibles assets. Column three and four use the corporate income tax rate (CIT) as the income shifting incentive measure. Columns five and six use the logarithm of earnings before interest and taxes as the dependent variable. All columns include a novel measure for the digitalization of firms (Digital).The digitalization index is determined as an additive index that captures if a firm has access to an ERP software, a database management system (DBMS) or groupware software. It is based on a yearly survey over the period 2005 to 2016. The dependent variable in the first four columns is the logarithm of profits before tax. All continuous variables are winsorized at the 1 and 99 percentile. We report standard errors clustered by firm in parentheses. ***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

C. Appendix to Section 4

Appendix 10: Dispersion of control banks over countries

Country	Banks		Percent	Country	Banks		Percent
	Number	Thereof parents			Number	Thereof parents	
Argentina	4	2	0.74	Niger	1	0	0.19
Australia	8	7	1.49	Nigeria	11	7	2.05
Bangladesh	18	18	3.35	Oman	1	1	0.19
Bermuda	12	7	2.23	Pakistan	10	6	1.86
Brazil	9	6	1.68	Palestine	1	1	0.19
Bulgaria	1	0	0.19	Panama	1	1	0.19
Canada	11	11	2.05	Peru	2	0	0.37
Chile	4	2	0.74	Philippines	6	5	1.12
China	18	16	3.35	Poland	1	0	0.19
Colombia	6	3	1.12	Qatar	7	6	1.30
Egypt	6	4	1.12	Russian Federation	5	5	0.93
Germany	1	0	0.19	Saudi Arabia	6	6	1.12
Ghana	2	1	0.37	Serbia	2	1	0.37
Hong Kong	15	11	2.79	Singapore	8	6	1.49
India	26	22	4.84	Slovenia	1	0	0.19
Indonesia	9	5	1.68	South Africa	9	7	1.68
Israel	6	6	1.12	Sri Lanka	8	7	1.49
Japan	43	37	8.01	Switzerland	20	18	3.72
Jordan	9	8	1.68	Syrian Arab Republic	1	0	0.19
Kazakhstan	4	2	0.74	Taiwan	22	21	4.10
Kenya	5	3	0.93	Tanzania	1	1	0.19
Korea	14	11	2.61	Thailand	15	9	2.79
Kuwait	7	6	1.30	Togo	1	1	0.19
Lebanon	2	2	0.37	Tunisia	10	6	1.86
Malaysia	12	8	2.23	Turkey	19	12	3.54
Mauritius	1	1	0.19	UAE	12	9	2.23
Mexico	5	4	0.93	USA	89	85	16.57
Morocco	4	4	0.74	Vietnam	4	4	0.74
New Zealand	1	1	0.19	**Total**	**537**	**433**	**100.00**

Notes: Control banks are stock-listed entities of bank groups whose global ultimate owner is located outside the EU. As some of these bank groups also have stock-listed subsidiaries in EU countries, the sample of treated banks also contains a few bank entities located in EU countries. In total, we have 537 control banks in our main sample. The depicted countries reflect the residence of the listed bank entities, which corresponds to the place of stock issuance. In general, the shares of listed banks are traded in the local currency of their home country, except for the shares of the two banks located in Lebanon (traded in USD) and of one bank in the U.S. (traded in EUR). The column "Banks – Thereof parents" depicts the number of banks in a country that are global ultimate owners (N=433).

Appendix 11: Engagement in tax havens sample split – extended tax haven classification

	(1)	(2)
Expected return:	S&P Global 1200	MSCI World Banks
Banks not engaging in tax havens		
26-28 Feb 2013	0.000	0.005
	(0.000)	(0.518)
Banks engaging in tax havens		
26-28 Feb 2013	-0.008	-0.002
	(-1.148)	(-0.359)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Banks are classified to be exposed to tax havens if they have an affiliate in a country that is categorized as a tax haven according to the Hines (2010) list. We gather the relevant information from hand-collected CbCRs. If we cannot obtain information from the public CbCR, we complement the sample by checking the residence of treated banks' affiliates. We employ CbCR data relating to the financial year 2014 since this is the first year for which the full CbCR information has to be published. Despite a small time lag between the first published CbCRs and our event date, we are confident that the tax haven activity at the time of the CbCR introduction is well reflected in the first wave of published CbCRs since it presumably takes time to react to the increase in tax transparency by withdrawing from tax havens. 37 (109) banks are part of a group without (with) an engagement in the selected tax havens. This test excludes the specification where the expected return is based on a control group of banks because comprehensive CbCRs are generally not available for banks with a global ultimate owner located outside the EU. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.176 and 0.273.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 12: Variation of event study method II – difference-in-differences

Three-day buy-and-hold return (26-28 February 2013)	
Bank HQ in EU	-0.00248**
	(0.00110)
26-28 Feb 2013 BHR	-0.00011
	(0.00085)
Bank HQ in EU # 26-28 Feb 2013 BHR	-0.00145
	(0.00110)
Constant	0.00381***
	(0.00085)
Observations	44,288
R-squared	0.00082

Notes: The table presents the results of the following difference-in-differences regression: $BHR_{i,t} = \beta_0 + \beta_1 TB_i + \beta_2 D_t + \beta_2 TB_i D_t + e_{p,t}$, which is comparable to the regression model of Hoopes et al. (2018). $BHR_{i,t}$ is the three-day buy-and-hold return (BHR) for each bank i, $BHR_{i,t} = \prod_{t=1}^{T}(1 + R_{i,t}^{act}) - 1$, centered at day t. The 155 treated banks are entities of bank groups whose global ultimate owner is located in the EU. The treatment dummy TB_i equals 1 for the treated banks and 0 for all banks in our sample with a global ultimate owner outside the EU. The time dummy D_t is equal to 1 only for the day that captures the buy-and-hold return for the three-day period from 26 to 28 February 2013, which includes our event date, and 0 otherwise. Similar to the time period used by Hoopes et al. (2018), the calculation of the buy-and-hold returns is based on daily return data from 1 January to 31 March 2013. In general, we would require that the regression allows for serial correlation and we acknowledge that the single constant is probably not sufficient to control for potential differences between the two groups.
Standard errors, clustered by calendar date, are in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 13: Variation of event study method I – OLS regression

	(1)	(2)	(3)
Average realized return:			
S&P Global 1200	0.75013***		
	(0.03043)		
MSCI World Banks		0.67430***	
		(0.02067)	
Control group			1.05753***
			(0.04662)
26-28 Feb 2013	-0.00213	-0.00031	-0.00107
	(0.00376)	(0.00154)	(0.00342)
Constant	0.00035*	0.00036**	-0.00006
	(0.00018)	(0.00015)	(0.00019)
Observations	783	783	783
R-squared	0.49444	0.67213	0.42855

Notes: The table presents the results of the following regression model: $R_{p,t} = \alpha_p + \beta_p R_{m,t} + \beta_d D_t + e_{p,t}$, which is comparable to the method of Chen (2017) and Frischmann et al. (2008). $R_{p,t}$ is the return of the portfolio of banks with an ultimate owner located in the EU (group of treated banks in all other specifications), $R_{m,t}$ is the return of the control index (S&P Global 1200; MSCI World Banks or the average return of the control group), D_t is a dummy set equal to 1 in the three-day event window, and $e_{p,t}$ is an error term. The coefficient can thus be interpreted as the three-day CAR at the event date. The estimation uses daily returns from 1 January 2012 to 31 December 2014.
Robust standard errors are in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 14: Cumulative average abnormal returns – alternative event dates

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
26-28 Jul 2013	-0.003	-0.001	-0.012
	(-0.350)	(-0.159)	(-1.150)
29-31 Oct 2014	-0.004	0.002	-0.014
	(-0.505)	(0.388)	(-1.512)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on alternative event dates. The first (second) row tests the main specification on 27 July 2013 (30 October 2014), where 177 (165) banks are in the sample of treated firms. Treated banks are entities of bank groups whose global ultimate owner is located in the EU.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 15: Modified event windows, buy-and-hold returns and sample modification

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Panel A: Modified event windows			
25-27 Feb 2013	-0.006	-0.002	-0.005
	(-0.823)	(-0.308)	(-0.573)
27 Feb - 4 Mar 2013	-0.004	0.001	-0.001
(4 trading days)	(-0.465)	(0.076)	(-0.137)
25 Feb - 1 Mar 2013	-0.003	0.001	-0.005
(5 trading days)	(-0.292)	(0.111)	(-0.409)
Panel B: Buy-and-hold average abnormal returns – three-day window centered on event date			
26-28 Feb 2013	-0.007	-0.001	-0.004
	(-0.902)	(-0.087)	(-0.424)
Panel C: Cumulative average abnormal returns for banks listed in the EU – three-day window centered on event date			
26-28 Feb 2013	-0.008	-0.003	-0.006
	(-1.175)	(-0.549)	(-0.691)

Notes: The 155 treated banks are entities of bank groups whose global ultimate owner is located in the EU. Panel A displays the cumulative average abnormal returns for alternative event windows. The first row shows the cumulative average abnormal returns if the event date is assumed to be the 26 February 2013 and includes the preceding day and the following day (25 February 2013 to 27 February 2013). The confidence intervals for the three specifications are [-0.021, 0.009], [-0.014, 0.010] and [-0.023, 0.012], respectively. Panel B displays the buy-and-hold average abnormal returns ($BHAAR = \frac{1}{N}\sum_{i=1}^{N}\left[\prod_{t=1}^{T}\left(1 + R_{i,t}^{act}\right) - \prod_{t=1}^{T}\left(1 + R_{i,t}^{exp}\right)\right]$) around the event date. The t-test statistic for this panel is skewness-adjusted. Panel C displays the cumulative average abnormal returns for a three-day window centered on the event date for 219 treated bank entities that are listed in the EU, irrespective of the location of the headquarter of the bank group.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 16: CAAR – only banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
26-28 Feb 2013	-0.007	-0.001	-0.004
	(-0.857)	(-0.114)	(-0.395)
	[-0.025, 0.010]	[-0.015, 0.013]	[-0.025, 0.017]

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The 130 treated banks are listed entities which are located in the EU and at the same time belong to a bank group whose global ultimate owner is located in the EU. Accordingly, the control group in column (3) consists of listed bank entities which are located in non-EU countries and at the same time belong to a bank group whose global ultimate owner is located outside the EU.
t-test statistic in parenthesis and 95% confidence interval in square brackets. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 17: Daily average abnormal returns – only banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
25 Feb 2013	0.006	0.000	0.001
	(1.039)	(0.039)	(0.217)
26 Feb 2013	-0.012**	-0.005	-0.012*
	(-2.193)	(-1.104)	(-1.887)
27 Feb 2013	-0.001	0.003	0.004
	(-0.125)	(0.593)	(0.650)
28 Feb 2013	0.005	0.001	0.004
	(0.945)	(0.322)	(0.573)

Notes: The table displays daily average abnormal returns. The 130 treated banks are listed entities which are located in the EU and at the same time belong to a bank group whose global ultimate owner is located in the EU. The control group in column (3) is defined as described in the notes to Appendix 16.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 18: ETR sample split – only banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with ETR below median ETR in the EU			
26-28 Feb 2013	0.007	0.012	0.004
	(0.452)	(0.846)	(0.287)
Banks with ETR above median ETR in the EU			
26-28 Feb 2013	-0.015	-0.007	-0.009
	(-1.241)	(-0.694)	(-0.546)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 16. We use the 2011 financial statements to calculate the ETR for our event. We split all listed banks according to the median ETR and then perform the data cleaning procedure described in Section 3. This can lead to slight numerical inequalities between the two ETR groups. The sample adjustment leaves us with 39 (44) treated banks with an ETR below (above) the median ETR. For the specification in column (3), the control group is split accordingly at the median ETR. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.000, 0.001 and 0.018, respectively. t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 19: Engagement in selected tax havens – only banks in EU countries

	(1)	(2)
Expected return:	S&P Global 1200	MSCI World Banks
Banks not engaging in selected tax havens		
26-28 Feb 2013	-0.005 (-0.611)	0.001 (0.162)
Banks engaging in selected tax havens		
26-28 Feb 2013	-0.010 (-0.979)	-0.003 (-0.321)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Following Overesch and Wolff (2019), banks that have an entity located in either Cyprus, Ireland, Liechtenstein, Luxembourg or Malta are considered to engage in tax havens. We gather the relevant information from hand-collected CbCRs. If we cannot obtain information from the public CbCR, we check annual reports of treated banks. We employ CbCR and annual report data for the financial year 2014 since this is the first year for which the full CbCR information has to be published. Despite a small time lag between financial year 2014 and our event date, we are confident that the tax haven activity at the time of the CbCR introduction is well reflected in the first wave of published CbCRs since it presumably takes time to react to the increase in tax transparency by withdrawing from tax havens. We reduce the sample to the treated banks for which we could find the relevant information. 60 (62) banks are part of a group without (with) an engagement in the selected tax havens. This test excludes the specification where the expected return is based on a control group of banks because comprehensive CbCRs are generally not available for banks with a global ultimate owner located outside the EU. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.330 and 0.424, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 20: B2B/B2C – only banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-average B2C orientation			
26-28 Feb 2013	-0.006 (-0.585)	-0.001 (-0.065)	-0.001 (-0.117)
Banks with an above-average B2C orientation			
26-28 Feb 2013	-0.009 (-0.730)	-0.001 (-0.116)	-0.006 (-0.374)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 16. Banks are classified according to the specialization code in Bank Focus: Commercial banks, Investment & Trust corporations, Investment banks, Private banking/ Asset management companies and Securities firms are assumed to be mainly B2B-oriented. Cooperative banks, Finance companies, Real Estate & Mortgage banks, Savings banks and Specialized governmental credit institutions are regarded to be mainly B2C-oriented. Central banks, Clearing and Custody institutions, Group finance companies, Islamic banks, Micro-financing institutions, Multi-lateral government banks and Other non-banking credit institutions are not considered. Consequently, 178 of 940 entities in the complete sample of banks listed on a stock market are categorized as B2C-oriented. At the group level, bank groups are classified to have a high or low B2C orientation depending on the fraction of affiliates with B2C orientation. We split all bank groups at the mean of the B2C fraction (about 20%). Hence, the treatment and control group are split in accordance. In the complete sample, about 30% of the bank groups are classified to have an above-average B2C orientation. Roughly in line with the ratio in the raw data, we have categorized 68 (33) treated banks as part of a group with a low (high) B2C orientation. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.564, 0.907 and 0.354, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 21: Ownership concentration – only banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-median share of institutional investors			
26-28 Feb 2013	-0.006	0.001	-0.003
	(-0.596)	(0.160)	(-0.265)
Banks with an above-median share of institutional investors			
26-28 Feb 2013	-0.010	-0.003	-0.006
	(-1.214)	(-0.480)	(-0.615)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 16. Banks are classified according to the proportion of institutional investors based on the shareholder data obtained from Bureau van Dijk's Orbis database, similar to Chen (2017). We use ownership data from the financial year 2013, which is our best proxy for the group structure at the event date. Based on this information on the investors, we calculate the share of institutional investors and split the sample at the median, which is at about 48%. We classify 63 (65) treated banks to have a below- (above-) median share of institutional investors. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.401, 0.334 and 0.578, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 22: CAAR – at least 10 banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
26-28 Feb 2013	-0.013	-0.006	-0.009
	(-1.548)	(-0.878)	(-0.975)
	[-0.028, 0.003]	[-0.019, 0.007]	[-0.028, 0.009]

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The treated banks are listed entities which are located in the EU and at the same time belong to a bank group whose global ultimate owner is located in the EU. As an additional restriction, we only consider entities located in EU countries with at least ten listed banks (i.e. Germany, France and United Kingdom). Consequently, we arrive at 58 treated banks. The control group in column (3) only consists of bank entities which are located in non-EU countries with more than ten listed banks and at the same time belong to a bank group whose global ultimate owner is located outside the EU.
t-test statistic in parenthesis and 95% confidence interval in square brackets. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 23: Daily average abnormal returns – at least 10 banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
25 Feb 2013	0.010**	0.005	0.008
	(2.003)	(1.153)	(1.266)
26 Feb 2013	-0.013***	-0.006	-0.013**
	(-2.575)	(-1.507)	(-2.190)
27 Feb 2013	-0.001	0.002	0.003
	(-0.293)	(0.444)	(0.485)
28 Feb 2013	0.002	-0.002	0.001
	(0.405)	(-0.387)	(0.149)

Notes: The table displays daily average abnormal returns. The 58 treated banks are listed entities which are located in Germany, France or the United Kingdom and at the same time belong to a bank group whose global ultimate owner is located in the EU. The control group in column (3) is defined as described in the notes to Appendix 22.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 24: ETR sample split – at least 10 banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with ETR below median ETR in the EU			
26-28 Feb 2013	0.004	0.009	-0.000
	(0.303)	(0.828)	(-0.011)
Banks with ETR above median ETR in the EU			
26-28 Feb 2013	-0.017	-0.009	-0.010
	(-1.551)	(-1.004)	(-0.686)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 22. We use the 2011 financial statements to calculate the ETR for our event. We split all listed banks according to the median ETR and then perform the data cleaning procedure described in Section 3. This can lead to slight numerical inequalities between the two ETR groups. The sample adjustment leaves us with 7 (17) treated banks with an ETR below (above) the median ETR. For the specification in column (3), the control group is split accordingly at the median ETR. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.021, 0.021 and 0.200, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 25: Engagement in selected tax havens – at least 10 banks in EU countries

	(1)	(2)
Expected return:	S&P Global 1200	MSCI World Banks
Banks not engaging in selected tax havens		
26-28 Feb 2013	-0.009	-0.002
	(-0.930)	(-0.270)
Banks engaging in selected tax havens		
26-28 Feb 2013	-0.017	-0.009
	(-1.640)	(-1.055)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Following Overesch and Wolff (2019), banks that have an entity located in either Cyprus, Ireland, Liechtenstein, Luxembourg or Malta are considered to engage in tax havens. We gather the relevant information from hand-collected CbCRs. If we cannot obtain information from the public CbCR, we check annual reports of treated banks. We employ CbCR and annual report data for the financial year 2014 since this is the first year for which the full CbCR information has to be published. Despite a small time lag between financial year 2014 and our event date, we are confident that the tax haven activity at the time of the CbCR introduction is well reflected in the first wave of published CbCRs since it presumably takes time to react to the increase in tax transparency by withdrawing from tax havens. We reduce the sample to the treated banks for which we could find the relevant information. 25 (28) banks are part of a group without (with) an engagement in the selected tax havens. This test excludes the specification where the expected return is based on a control group of banks because comprehensive CbCRs are generally not available for banks with a global ultimate owner located outside the EU. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.314 and 0.367, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 26: B2B/B2C – at least 10 banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-average B2C orientation			
26-28 Feb 2013	-0.010	-0.004	-0.003
	(-1.331)	(-0.552)	(-0.289)
Banks with an above-average B2C orientation			
26-28 Feb 2013	-0.015	-0.007	-0.013
	(-1.049)	(-0.550)	(-0.735)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 22. Banks are classified according to the specialization code in Bank Focus: Commercial banks, Investment & Trust corporations, Investment banks, Private banking/ Asset management companies and Securities firms are assumed to be mainly B2B-oriented. Cooperative banks, Finance companies, Real Estate & Mortgage banks, Savings banks and Specialized governmental credit institutions are regarded to be mainly B2C-oriented. Central banks, Clearing and Custody institutions, Group finance companies, Islamic banks, Micro-financing institutions, Multi-lateral government banks and Other non-banking credit institutions are not considered. Consequently, 178 of 940 entities in the complete sample of banks listed on a stock market are categorized as B2C-oriented. At the group level, bank groups are classified to have a high or low B2C orientation depending on the fraction of affiliates with B2C orientation. We split all bank groups at the mean of the B2C fraction (about 20%). Hence, the treatment and control group are split in accordance. In the complete sample, about 30% of the bank groups are classified to have an above-average B2C orientation. Roughly in line with the ratio in the raw data, we have categorized 26 (16) treated banks as part of a group with a low (high) B2C orientation. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.478, 0.642 and 0.140, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 27: Ownership concentration – at least 10 banks in EU countries

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-median share of institutional investors			
26-28 Feb 2013	-0.014	-0.007	-0.011
	(-1.549)	(-0.949)	(-0.998)
Banks with an above-median share of institutional investors			
26-28 Feb 2013	-0.011	-0.004	-0.008
	(-1.207)	(-0.519)	(-0.684)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 22. Banks are classified according to the proportion of institutional investors based on the shareholder data obtained from Bureau van Dijk's Orbis database, similar to Chen (2017). We use ownership data from the financial year 2013, which is our best proxy for the group structure at the event date. Based on this information on the investors, we calculate the share of institutional investors and split the sample at the median, which is at about 48%. We classify 28 (29) treated banks to have a below- (above-) median share of institutional investors. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.736, 0.623 and 0.618, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 28: CAAR – only global ultimate owner banks

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
26-28 Feb 2013	-0.008	-0.001	-0.004
	(-0.793)	(-0.069)	(-0.336)
	[-0.026, 0.011]	[-0.016, 0.015]	[-0.027, 0.019]

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The 104 treated banks are the listed global ultimate owners of bank groups headquartered in the EU, i.e. the restricted sample does not contain any listed subsidiaries. The control group in column (3) is the same as used throughout the main tests in the paper.
t-test statistic in parenthesis and 95% confidence interval in square brackets. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 29: Daily average abnormal returns – only global ultimate owner banks

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
25 Feb 2013	0.003	-0.003	-0.002
	(0.447)	(-0.615)	(-0.265)
26 Feb 2013	-0.012**	-0.005	-0.012*
	(-2.012)	(-0.949)	(-1.722)
27 Feb 2013	0.001	0.004	0.006
	(0.130)	(0.847)	(0.835)
28 Feb 2013	0.004	-0.000	0.002
	(0.643)	(-0.011)	(0.333)

Notes: The table displays daily average abnormal returns. The 104 treated banks are the listed global ultimate owners of bank groups headquartered in the EU. The control group in column (3) is defined as described in the notes to Appendix 28. t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 30: ETR sample split – only global ultimate owner banks

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with ETR below median ETR in the EU			
26-28 Feb 2013	0.008	0.014	0.007
	(0.370)	(0.686)	(0.314)
Banks with ETR above median ETR in the EU			
26-28 Feb 2013	-0.016	-0.007	-0.010
	(-1.358)	(-0.775)	(-0.607)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 28. We use the 2011 financial statements to calculate the ETR for our event. We split all listed banks according to the median ETR and then perform the data cleaning procedure described in Section 3. This can lead to slight numerical inequalities between the two ETR groups. The sample adjustment leaves us with 27 (35) treated banks with an ETR below (above) the median ETR. For the specification in column (3), the control group is split accordingly at the median ETR. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.001, 0.002 and 0.014, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 31: Engagement in selected tax havens – only global ultimate owner banks

	(1)	(2)
Expected return:	S&P Global 1200	MSCI World Banks
Banks not engaging in selected tax havens		
26-28 Feb 2013	-0.004	0.002
	(-0.488)	(0.322)
Banks engaging in selected tax havens		
26-28 Feb 2013	-0.012	-0.004
	(-0.944)	(-0.324)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. Following Overesch and Wolff (2019), banks that have an entity located in either Cyprus, Ireland, Liechtenstein, Luxembourg or Malta are considered to engage in tax havens. We gather the relevant information from hand-collected CbCRs. If we cannot obtain information from the public CbCR, we check annual reports of treated banks. We employ CbCR and annual report data for the financial year 2014 since this is the first year for which the full CbCR information has to be published. Despite a small time lag between financial year 2014 and our event date, we are confident that the tax haven activity at the time of the CbCR introduction is well reflected in the first wave of published CbCRs since it presumably takes time to react to the increase in tax transparency by withdrawing from tax havens. We reduce the sample to the treated banks for which we could find the relevant information. 50 (47) banks are part of a group without (with) an engagement in the selected tax havens. This test excludes the specification where the expected return is based on a control group of banks because comprehensive CbCRs are generally not available for banks with a global ultimate owner located outside the EU. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.150 and 0.285, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Appendix 32: B2B/B2C – only global ultimate owner banks

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-average B2C orientation			
26-28 Feb 2013	-0.007	-0.002	-0.002
	(-0.655)	(-0.160)	(-0.184)
Banks with an above-average B2C orientation			
26-28 Feb 2013	-0.007	0.001	-0.005
	(-0.552)	(0.084)	(-0.267)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 28. Banks are classified according to the specialization code in Bank Focus: Commercial banks, Investment & Trust corporations, Investment banks, Private banking/ Asset management companies and Securities firms are assumed to be mainly B2B-oriented. Cooperative banks, Finance companies, Real Estate & Mortgage banks, Savings banks and Specialized governmental credit institutions are regarded to be mainly B2C-oriented. Central banks, Clearing and Custody institutions, Group finance companies, Islamic banks, Micro-financing institutions, Multi-lateral government banks and Other non-banking credit institutions are not considered. Consequently, 178 of 940 entities in the complete sample of banks listed on a stock market are categorized as B2C-oriented. At the group level, bank groups are classified to have a high or low B2C orientation depending on the fraction of affiliates with B2C orientation. We split all bank groups at the mean of the B2C fraction (about 20%). Hence, the treatment and control group are split in accordance. In the complete sample, about 30% of the bank groups are classified to have an above-average B2C orientation. Roughly in line with the ratio in the raw data, we have categorized 60 (20) treated banks as part of a group with a low (high) B2C orientation. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.982, 0.642 and 0.705, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

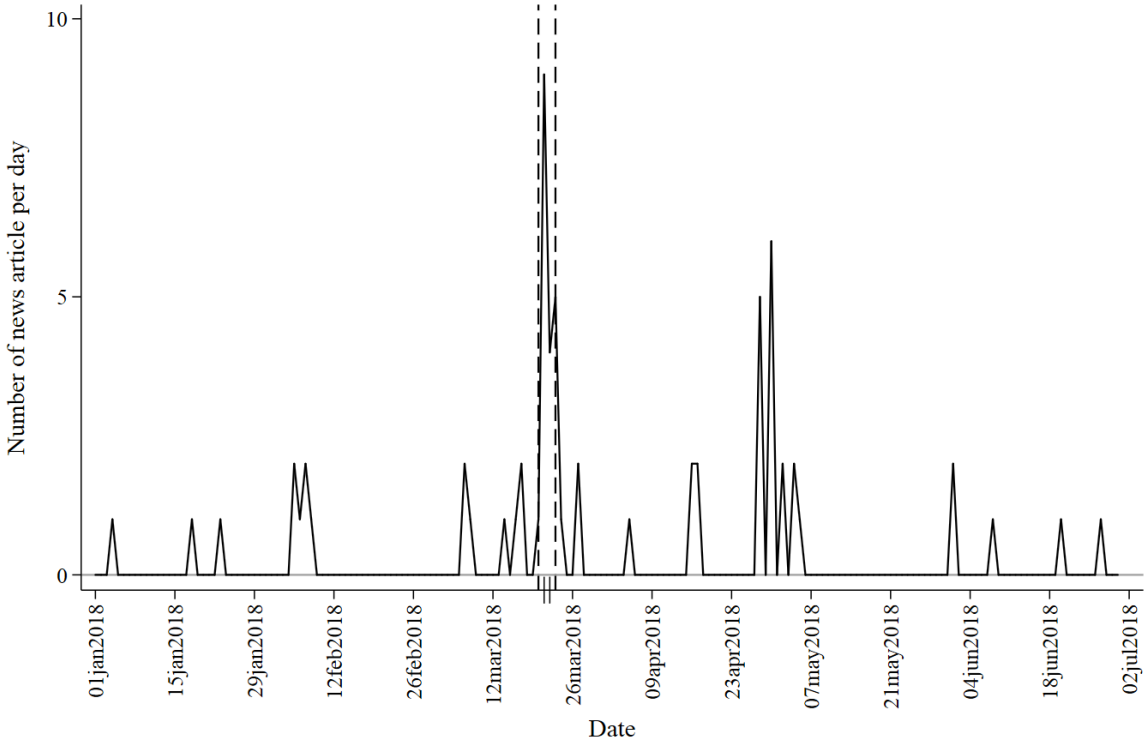
Appendix 33: Ownership concentration – only global ultimate owner banks

	(1)	(2)	(3)
Expected return:	S&P Global 1200	MSCI World Banks	Control group
Banks with a below-median share of institutional investors			
26-28 Feb 2013	-0.006	0.002	-0.003
	(-0.518)	(0.196)	(-0.211)
Banks with an above-median share of institutional investors			
26-28 Feb 2013	-0.011	-0.004	-0.006
	(-1.211)	(-0.476)	(-0.576)

Notes: The table displays the cumulative average abnormal returns for a three-day window centered on the event date. The control group in column (3) is defined as described in the notes to Appendix 28. Banks are classified according to the proportion of institutional investors based on the shareholder data obtained from Bureau van Dijk's Orbis database, similar to Chen (2017). We use ownership data from the financial year 2013, which is our best proxy for the group structure at the event date. Based on this information on the investors, we calculate the share of institutional investors and split the sample at the median, which is at about 48%. We classify 53 (48) treated banks to have a below- (above-) median share of institutional investors. The p-value of a paired test on the difference between the estimated cumulative average abnormal returns of the two groups is 0.377, 0.312 and 0.512, respectively.
t-test statistic in parenthesis. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

D. Appendix to Section 5

Appendix 34: Factiva search on media articles covering "EU Digital Tax" topics



Notes: We plot the number of articles per day that cover the topic of "EU Digital Tax" based on a Factiva search over the first six months of 2018. Overall, we find 64 different articles on the topic. The dates enclosed by the light grey scattered lines are our event window. The crossing ticks on the x-axis represent March 21 and March 22, 2018, respectively.

Appendix 35: List of 10-K annual reports with reference to the digital tax package

Filed	Reporting for	Filing entity/person
Search Term: "digital services tax"		
26-Feb-20	31-Dec-19	Booking Holdings Inc. (BKNG)
28-Feb-20	31-Dec-19	ANGI Homeservices Inc. (ANGI)
20-Mar-20	31-Dec-19	TRAVELZOO (TZOO)
27-Feb-19	31-Dec-18	Booking Holdings Inc. (BKNG)*
19-Feb-20	31-Dec-19	TripAdvisor, Inc. (TRIP)
28-Feb-20	31-Dec-19	IAC/INTERACTIVECORP (MTCH)
27-Feb-19	31-Dec-18	Gannett Co., Inc.
22-Feb-19	31-Dec-18	Liberty TripAdvisor Holdings, Inc. (LTRPA, LTRPB)*
27-Feb-20	31-Dec-19	Match Group, Inc.
19-Feb-20	31-Dec-19	Liberty TripAdvisor Holdings, Inc. (LTRPA, LTRPB)
4-Feb-21	31-Dec-20	EBAY INC (EBAY, EBAYL)
2-Mar-20	31-Dec-19	Gannett Co., Inc. (GCI)
8-Feb-19	31-Dec-18	Expedia Group, Inc. (EXPE)*
22-Feb-19	31-Dec-18	TripAdvisor, Inc. (TRIP)*
14-Feb-20	31-Dec-19	Expedia Group, Inc. (EXPE)
8-Feb-19	31-Dec-18	Liberty Expedia Holdings, Inc.*
10-Dec-19	30-Sep-19	LIQUIDITY SERVICES INC (LQDT)
1-Mar-19	31-Dec-18	ANGI Homeservices Inc. (ANGI)
30-Jan-19	31-Dec-18	EBAY INC (EBAY, EBAYL)
31-Jan-20	31-Dec-19	EBAY INC (EBAY, EBAYL)
23-Jul-20	31-Mar-20	MiX Telematics Ltd (MIXT)
17-Sep-20	31-Jul-20	Zscaler, Inc. (ZS)
1-Mar-19	31-Dec-18	IAC/INTERACTIVECORP (MTCH)
2-Mar-20	31-Dec-19	Clarivate Analytics PLC (CCC)
Search Term: "digital tax"		
Search Term: "digital service tax"		
19-Feb-20	31-Dec-19	TripAdvisor, Inc. (TRIP)
11-Feb-20	31-Dec-19	VARONIS SYSTEMS INC (VRNS)
9-Feb-21	31-Dec-20	VARONIS SYSTEMS INC (VRNS)
4-Feb-21	31-Dec-20	EBAY INC (EBAY, EBAYL)
19-Feb-20	31-Dec-19	Liberty TripAdvisor Holdings, Inc. (LTRPA, LTRPB)
21-Feb-20	31-Dec-19	DROPBOX, INC. (DBX)*
18-Feb-20	31-Dec-19	Groupon, Inc. (GRPN)
19-Feb-20	31-Dec-19	TWITTER, INC. (TWTR)*
31-Jan-20	31-Dec-19	EBAY INC (EBAY, EBAYL)
12-Feb-19	31-Dec-18	Groupon, Inc. (GRPN)
7-Mar-19	31-Dec-18	Upwork Inc. (UPWK)
28-Feb-19	31-Dec-18	ETSY INC (ETSY)
14-Feb-20	31-Dec-19	Expedia Group, Inc. (EXPE)
27-Feb-20	31-Dec-19	ETSY INC (ETSY)
2-Mar-20	31-Dec-19	Upwork Inc. (UPWK)
6-Feb-20	31-Dec-19	Intercontinental Exchange, Inc. (ICE)
7-Feb-19	31-Dec-18	Intercontinental Exchange, Inc. (ICE)
Search Term: "taxation of the digital economy"		
14-Feb-20	31-Dec-19	VERISIGN INC/CA (VRSN)
1-Apr-19	31-Dec-18	True Nature Holding, Inc. (MITI, TNTY)*
8-Feb-19	29-Dec-18	CERNER CORP /MO/ (CERN)*
7-Feb-20	31-Dec-19	PINTEREST, INC. (PINS)*
5-Feb-21	31-Dec-20	PINTEREST, INC. (PINS)*
27-Feb-19	29-Dec-18	CADENCE DESIGN SYSTEMS INC (CDNS)
20-Feb-18	30-Dec-17	CADENCE DESIGN SYSTEMS INC (CDNS)
24-Feb-20	28-Dec-19	CADENCE DESIGN SYSTEMS INC (CDNS)
10-Feb-20	28-Dec-19	CERNER Corp (CERN)*

Filed	Reporting for	Filing entity/person
Search Term: "taxation of the digital economy"		
20-Mar-20	31-Jan-20	Zoom Video Communications, Inc. (ZM)
22-Feb-19	31-Dec-18	Liberty TripAdvisor Holdings, Inc. (LTRPA, LTRPB)*
19-Feb-20	31-Dec-19	Liberty TripAdvisor Holdings, Inc. (LTRPA, LTRPB)
28-Feb-20	31-Dec-19	YELP INC (YELP)
19-Feb-20	31-Dec-19	TWITTER, INC. (TWTR)*
2-Mar-20	31-Dec-19	Upland Software, Inc. (UPLD)
5-Mar-20	31-Jan-20	SALESFORCE.COM, INC. (CRM)
4-Mar-20	31-Dec-19	Cloudflare, Inc. (NET)*
1-Apr-20	31-Dec-19	True Nature Holding, Inc. (MITI, TNTY)*
27-Feb-19	31-Dec-18	Booking Holdings Inc. (BKNG)*
19-Feb-20	31-Dec-19	TripAdvisor, Inc. (TRIP)
22-Feb-19	31-Dec-18	TripAdvisor, Inc. (TRIP)*
18-Mar-20	31-Dec-19	Maiden Holdings, Ltd. (MHLD)
Search Term: "taxation of specified digital services"		
7-Feb-20	31-Dec-19	PINTEREST, INC. (PINS)*
5-Feb-21	31-Dec-20	PINTEREST, INC. (PINS)*
4-Mar-20	31-Dec-19	Cloudflare, Inc. (NET)*
6-Feb-19	31-Dec-18	Snap Inc (SNAP)*
2-Mar-20	31-Dec-19	Uber Technologies, Inc (UBER)*
Search Term: "taxation of digital services"		
14-Feb-20	31-Dec-19	HONEYWELL INTERNATIONAL INC (HON)
12-Feb-21	31-Dec-20	HONEYWELL INTERNATIONAL INC (HON)
22-Feb-19	31-Dec-18	Travelport Worldwide LTD
Search Term: "digital services taxes"		
26-Feb-20	31-Dec-19	Booking Holdings Inc. (BKNG)
20-Mar-20	31-Dec-19	TRAVELZOO (TZOO)
11-Aug-20	30-Jun-20	NEWS CORP (NWS, NWSA)
2-Mar-20	31-Dec-19	ROKU, INC (ROKU)
27-Feb-20	31-Dec-19	Activision Blizzard, Inc. (ATVI)
20-May-20	31-Mar-20	ELECTRONIC ARTS INC. (EA)
4-Feb-20	31-Dec-19	Alphabet Inc. (GOOG, GOOGL)
24-May-19	31-Mar-19	ELECTRONIC ARTS INC. (EA)
3-Feb-21	31-Dec-20	Alphabet Inc. (GOOG, GOOGL)
6-Feb-20	31-Dec-19	PayPal Holdings, Inc. (PYPL)
12-Feb-21	31-Dec-20	Expedia Group, Inc. (EXPE)
5-Feb-21	31-Dec-20	PayPal Holdings, Inc. (PYPL)
26-Feb-20	31-Dec-19	Square, Inc. (SQ)
11-Feb-21	31-Dec-20	Carlyle Group Inc. (CG)
8-Feb-19	31-Dec-18	Expedia Group, Inc. (EXPE)*
14-Feb-20	31-Dec-19	Expedia Group, Inc. (EXPE)
8-Feb-19	31-Dec-18	Liberty Expedia Holdings, Inc.*
26-Feb-20	31-Dec-19	Sabre Corp (SABR)
13-Aug-19	30-Jun-19	NEWS CORP (NWS, NWSA)
2-Mar-20	31-Dec-19	Uber Technologies, Inc (UBER)*
27-Feb-20	31-Dec-19	Chubb Ltd (CB)
12-Feb-20	31-Dec-19	Carlyle Group Inc. (CG)
13-Feb-19	31-Dec-18	Carlyle Group L.P. (CG)
Search Term: "digital service taxes"		
18-Feb-20	31-Dec-19	Groupon, Inc. (GRPN)
26-Feb-20	31-Dec-19	Booking Holdings Inc. (BKNG)
12-Feb-19	31-Dec-18	Groupon, Inc. (GRPN)
26-Feb-20	31-Dec-19	Square, Inc. (SQ)A62C100A68:C108

**Indicates mentioning of March 2018/ EU Comission 2018*

Appendix 36: Exemplary risk statements in annual reports

Corporation	10-K risk statement
Booking Holdings Inc.	“In March 2018, the European Commission, also working on determining a solution to the tax treatment of the digital economy, released two draft directives on the Taxation of the Digital Economy. Although these proposals were not approved, a number of E.U. member states have indicated they will unilaterally introduce a digital services tax.” 10-K December 2018 p. 21
Cerner Corp	"Further, during 2018, the European Commission issued proposals and the OECD issued an interim report related to the taxation of the digital economy. As these and other tax laws and related regulations change, our financial results could be materially impacted." 10-K December 2018 p. 13
Ebay Inc.	"Similarly, in Europe, and elsewhere in the world, there are various tax reform efforts underway designed to ensure that corporate entities are taxed on a larger percentage of their earnings. Companies that operate over the Internet, such as eBay, are a target of some of these efforts. If more taxing authorities are successful in applying direct taxes to Internet companies that do not have a physical presence in their respective jurisdictions, this could increase our effective tax rate." 10-K December 2018 p. 23
Expedia Group, Inc.	“Following the OECD’s announcement, the European Commission published proposals for European Union (“EU”) member states to introduce a new digital services tax on the revenue of companies that provide certain digital services.” 10-K December 2018 p. 20
Facebook, Inc.	“Similarly, the European Commission and several countries have issued proposals that would change various aspects of the current tax framework under which we are taxed. These proposals include changes to the existing framework to calculate income tax, as well as proposals to change or impose new types of non-income taxes, including taxes based on a percentage of revenue. For example, the United Kingdom, Spain, Italy, and France have each proposed taxes applicable to digital services, which includes business activities on social media platforms and online marketplaces, and would likely apply to our business.” 10-K December 2018 p. 26
Godaddy Inc.	"Due to the global nature of the Internet, it is possible that any U.S. or foreign federal, state or local taxing authority might attempt to regulate our transmissions or levy transaction, income or other taxes relating to our activities. Tax authorities at the international, federal, state and local levels are regularly reviewing the appropriate treatment of companies engaged in e-commerce." 10-K December 2018 p. 44
Groupon, Inc.	"taxation (including the European Union's voucher directive, digital service tax and similar regulations)" 10-K December 2018 p. 15
Liberty Expedia Holdings, Inc.	"In March 2018, the OECD proposed measures to address the application of corporate tax to companies operating in the digital economy. Following the OECD’s announcement, the European Commission published proposals for European Union (“EU”) member states to introduce a new digital services tax on the revenues of companies that provide certain digital services." 10-K December 2018 p. 31
Liberty Tripadvisor Holdings, Inc.	"The second directive provides for an interim solution whereby EU States are to apply a 3% revenue based Digital Services Tax, which if enacted, would be effective beginning in 2020. In the interim, certain EU States (Austria, France, Italy, Spain, Belgium and the United Kingdom) have proposed legislation to implement a Digital Services Tax that, if enacted, would impose a tax on revenue earned by larger companies from users of digital services located in these respective EU States as early as 2019." 10-K December 2018 p. 31
Match Group, Inc.	"The European Commission and several European countries have issued proposals that would change various aspects of the current tax framework under which we are taxed, including proposals to change or impose new types of non-income taxes (including taxes based on a percentage of revenue)." 10-K December 2018 p. 27
Paypal Holdings, Inc.	"Various levels of government, such as U.S. federal and state legislatures, and international organizations, such as the Organization for Economic Co-operation and Development (“OECD”) and the EU, are increasingly focused on tax reform and other legislative or regulatory action to increase tax revenue. Any such tax reform or other legislative or regulatory actions could increase our effective tax rate." 10-K December 2018 p. 29
Red Hat Inc.	“Moreover, the European Commission and some foreign jurisdictions have introduced proposals to impose a separate tax on specified digital service activity. It is unclear how or if such proposals, if enacted, would impact us.” 10-K February 2019 p.33
Twitter, Inc.	“In addition, many countries in Europe, as well as a number of other countries and organizations, have recently proposed changes to tax laws regarding digital services that could significantly increase our tax obligations in many countries where we do business or require us to change the manner in which we operate our business.” 10-K December 2018 p. 38

Appendix 37: Core media topics around the event window

Topic	Number of Articles in Newspapers			
	Wall Street Journal	Washington Post	New York Times	Guardian
European Commission's Digital Tax Proposals	3	1	1	1
Facebook Data Leak	4	1	1	2
International Trade / Tariffs Discussion	3	2	3	2

Notes: The table depicts the number of articles in the respective journal referring to a core media topic in the event window.

Appendix 38: List of affected firms

58.Com Inc.	Digital China Holdings Limited	Line Corporation	Scientific Games Corp
Activision Blizzard, Inc.	Discovery, Inc.	Masmovil Ibercom, S.A.	Scsk Corporation
Akamai Technologies INC	DUN & Bradstreet Corp.	Match Group, Inc.	Senshukai CO LTD
Alibaba Group Holding Limited	DXC Technology Company	Maxar Technologies Inc.	Servicenow, Inc.
Alliance Data Systems Corp	Ebay INC	Mediaset S.P.A.	Seven West Media Limited
Allscripts Healthcare Solutions INC	Econocom Group SA	Meredith Corp	SG & G Coporation
Alphabet Inc.	Elanders AB	Micro Focus International PLC	Shanghai Ganglian E-Commerce Holdings Company Limited
Altran Technologies SA	Electronic Arts INC	Mixi Inc.	SK Holdings Co., Ltd.
Amadeus IT Group, S.A.	Entertainment ONE Limited	Modern Times Group AB	SKY Limited
Amazon.Com, Inc.	EOH Holdings Limited	Moody's Corporation	Softbank Group Corp
AMC Networks Inc.	Epam Systems, Inc.	Mphasis Limited	Solocal Group S.A.
Amdocs Limited	Equifax INC	N Brown Group PLC	Sonda S.A.
Anhui Xinhua Media Company Limited	Equinix INC	Nasdaq, Inc.	Sopra Steria Group
Arnoldo Mondadori Editore SPA	Esprinet S.P.A.	Naspers Limited	Square Enix Holdings Co., Ltd.
Asos PLC	Expedia Group, Inc.	Naver Corporation	Super Micro Computer, Inc.
Asseco Poland S.A.	Experian PLC	NET ONE Systems CO LTD	Sykes Enterprises INC
Atos SE	Facebook, Inc.	Netapp, Inc.	Synaptics Incorporated
Autohome Inc.	Factset Research Systems INC	Netease, Inc.	Systemax INC
Automatic Data Processing INC	Fairfax Media Limited	Netflix, Inc.	T-Gaia Corp.
Axel Springer SE	First Data Corporation	Netscout Systems INC	Take-Two Interactive Software Inc.
Baidu Inc.	Fiserv INC	NEW Media Investment Group Inc.	Takkt AG
Bechtle AG	Formula Systems (1985) Limited	NEW York Times CO	Tata Consultancy Services Limited
Belluna CO LTD	Fuji Soft Inc.	News Corporation	Tech Mahindra Limited
Bitauto Holdings LTD	Gakken Holdings Co., Ltd.	Nexon CO LTD	Teradata Corporation
Booking Holdings Inc.	Gannett Co., Inc.	Next PLC	Thomson Reuters Corporation
Broadridge Financial Solutions, Inc.	Gartner INC	Nielsen Holdings PLC	Transcosmos INC
Caci International INC	Gemalto N.V.	Nomura Research Institute, Ltd.	Transunion
Cancom SE	Global Payments INC	NTT Data Corporation	Travelport Worldwide Limited
Capgemini SE	GMO Internet Inc.	Otsuka Corporation	Trend Micro Incorporated
CBS Corporation	Godaddy Inc.	Overstock.Com, Inc.	Trivago N.V.
CDW Corp	Graham Holdings Company	Paypal Holdings, Inc.	Twenty-First Century Fox, Inc.
Cerner Corp	Groupon, Inc.	PC Connection INC	Twitter, Inc.
Check Point Software Technologies Limited	Grupo Televisa S.A.B. de C.V.	Pcm, Inc.	Ubisoft Entertainment SA
China South Publishing & Media Group Company Limited	GS Home Shopping Inc.	Pearson PLC	Verint Systems, Inc.
Chinasoft International Limited	HCL Technologies Limited	Pivot Technology Solutions, Inc.	Verisign INC
Cimpress N.V.	Henan Dayou Energy Co., Ltd.	Playtech PLC	Verisk Analytics, Inc.
CIR S.P.A. - Compagnie Industriali Riunite Siglabile CIR S.P.A.	Henry Jack & Associates INC	Presidio, Inc.	Viacom, Inc.
Citrix Systems INC	Houghton Mifflin Harcourt Company	Prosiebensat.1 Media SE	Vipshop Holdings LTD
CJ ENM CO. Ltd.	Iliad	Quebecor INC	Virtusa Corporation
Cofide - Gruppo de Benedetti S.P.A.	Indra Sistemas SA	Qurate Retail, Inc.	Vmware, Inc.
Cognizant Technology Solutions Corp	Informa PLC	Rakuten INC	Wayfair Inc.
Comcast Corporation	Infosys Limited	RED HAT INC	Weibo Corporation
Computacenter PLC	Insight Enterprises INC	Redington (India) Ltd.	Wipro Limited
Conexio Corporation	Internet Initiative Japan INC	Relx PLC	Wirecard AG
Constellation Software Inc.	Itochu Techno-Solutions Corporation	Reply S.P.A.	Wolters Kluwer NV
Convergys Corp	Jd.Com Incorporated	Rizap Group, Inc.	Workday, Inc.
Copart INC	Jiangsu Phoenix Publishing & Media Corporation Limited	Rizzoli Corriere Della Sera Mediagroup S.P.A.	Worldline
CoreLogic Inc.	John Wiley & Sons, Inc.	RTL Group SA	Xinhua Winshare Publishing and Media Co., Ltd.
Criteo SA	Kadokawa Dwango Corporation	S&P Global Inc.	Yandex N.V.
Cyberagent INC	Konami Holdings Corporation	Sabre Corporation	Yirendai Ltd.
DAI Nippon Printing CO LTD	Lagardere SCA	Salesforce.Com, Inc.	Yonyou Network Technology Co., Ltd.
Daily Mail and General Trust PLC	Larsen & Toubro Infotech Limited	Samsung SDS Co.,Ltd.	YY Inc.
Daou Tech Inc.	Leidos Holdings, Inc.	Sanoma OYJ	Zalando SE
Dassault Systemes SE	Liberty Expedia Holdings, Inc.	Schibsted ASA	Zozo, Inc.
Datatec Limited	Liberty Global PLC	Scholastic Corp	
DHC Software Co., Ltd.	Liberty Tripadvisor Holdings, Inc.	Science Applications International Corp	

Notes: In total, 222 companies are classified to be affected by the EU Commission's proposals. The country dispersion is as follows: Australia 2; Belgium 1; Bermuda 1; Canada 5 Cayman Islands 12; Chile 1; China 8; Finland 1; France 11; Germany 7; India 8; Israel 2; Italy 7; Japan 28; South Korea 7; Luxembourg 1; Mexico 1; Netherlands 5; Norway 1; Poland 1; South Africa 3; Spain 3; Sweden 2; UK 15; U.S. 88.

Appendix 39: Cumulative average abnormal returns – alternative event study method

	(1)
Expected return estimation	market model
21-22 Mar. 2018	-0.690*
	(0.417)

Notes: This model estimates the cumulative average abnormal return (*CAAR*) in line with Kothari and Warner (2007). $CAAR(t_0, t_1) = \sum_{t=t_0}^{t=t_1} \left(\frac{1}{N}\sum_{i=1}^{i=N} AR_{it}\right)$. Daily abnormal returns AR_{it} are calculated as the difference between actual returns and expected returns $AR_{it} = R_{it} - R_{it}^{exp}$. We use parameters from the market model regression for each individual firm to estimate the expected return $R_{i,t}^{exp}$: $AR_{it} = R_{it} - (\widehat{\alpha_\iota} + \widehat{\beta_\iota} R_{mt})$. R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. The ratio of the *CAAR* and its estimated standard deviation ($\hat{s}$) provides – in the absence of abnormal returns – a normally distributed test statistic. The 222 treated firms are stock-listed firms whose global consolidated revenue exceeds 750 million euros and the firms operate in an industry that is likely to be affected by the EU digital tax proposal. Standard errors are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 40: Cumulative average abnormal return – Fama-French three factor model

	(1)
	Stock return (adjusted for the risk free rate of return)
Alpha	0.017
	(0.015)
Market return (S&P 1200)	0.883***
	(0.037)
FF-SMB Factor	0.166**
	(0.073)
FF-HML Factor	-0.312***
	(0.066)
21-22 Mar. 2018	-0.730***
	(0.109)
Observations	53,724
Firms	222
Adj.-R2	0.076

Notes: The model presents the results using the Fama-French three-factor model to estimate abnormal returns (Fama and French, 1993; Kothari and Warner, 2007): $R_{it} - R_{ft} = \alpha + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \gamma D_t + e_{it}$. This model expands the conditional market model by adding the risk-free rate of return, R_{ft}, size risk, SMB_t, and value risk, HML_t, to the equation. We obtain daily data for the market excess return, the size and value factor returns, as well as the risk-free rate from Ken French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ ken.french/data_library.html#Research). The risk-free rate is virtually zero on almost all trading days. Equivalently to the market model regression, γ provides an estimate for the average abnormal return of our treated portfolio of digital firms during the event window. The average abnormal return has to be multiplied with the number of days in the event window to obtain the CAAR. The coefficients can be interpreted correspondingly. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 41: Value-weighted portfolio

	(1) Stock return
Alpha	0.036**
	(0.016)
Market return (S&P 1200)	0.473***
	(0.125)
21-22 Mar. 2018	-0.590***
	(0.159)
Observations	53,724
Firms	222
Adj.-R2	0.016

Notes: This table presents the results of the conditional market model with a value-weighted portfolio. It reflects the sum of each firm's market capitalization in the sample on each day in the estimation and event window. The model is the following: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}$. R_{it} is the value-weighted return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 222 treated firms and β is the estimate of the portfolio's market beta. The coefficient estimate of γ_i (and the corresponding standard error) is multiplied by two to account for the length of the two-day event window (Eckbo et al. 2007). γ can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the two-day event window. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 42: Alternative test statistics

	(1)
Expected return estimation	Market model
21-22 Mar 2018	-0.690
Parametric test alternative	(-1.809)*
Corrado rank-sum test	(-2.438)*

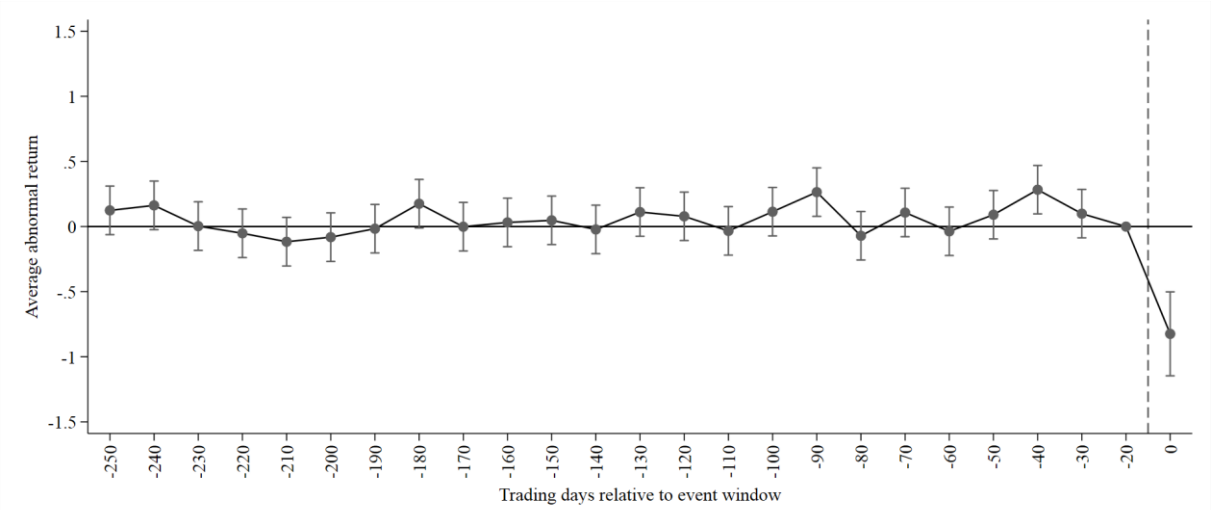
Notes: The table depicts additional parametric and non-parametric test statistics for the main results (Bernard, 1987; Campbell et al., 1997). The parametric test alternative is based on Kothari and Warner (2007) in Appendix 39 and is calculated as $t_{parametric\,2} = \frac{CAAR(0,1)}{\sqrt{s^2(CAAR(d))}}$, with $s^2(CAAR(d))$ as the variance of cumulated average abnormal two-day returns in the estimation period. The Corrado rank-sum test (Corrado, 1989) is calculated as $z_{Rank} = \frac{\sum_{t=0}^{t=1} \frac{1}{242} \sum_{i=1}^{242} (k_{i,t} - E(k))}{\sqrt{d \times s^2(k)}}$, with $K_{i,t}$ denoting the rank of the abnormal return of firm i at day t in the time series. The expected rank $E(k)$ is one-half plus half the number of time-series days and *d* is the number of days. The test statistic is assumed to be distributed asymptotic standard normal. Test statistics are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 43: Comparison of affected and unaffected firms

	(1) Stock return
Digital x Large x Event (21-22 Mar. 2018)	-0.832***
	(0.055)
Digital x Large	0.003
	(0.088)
Digital x Event (21-22 Mar. 2018)	0.149***
	(0.045)
Large x Event (21-22 Mar. 2018)	0.286***
	(0.025)
Digital	-0.013
	(0.083)
Large	-0.505***
	(0.030)
Event (21-22 Mar. 2018)	-0.615***
	(0.037)
Constant	0.601***
	(0.041)
Observations	4,203,540
Firms	17,370
Adj.-R2	0.003

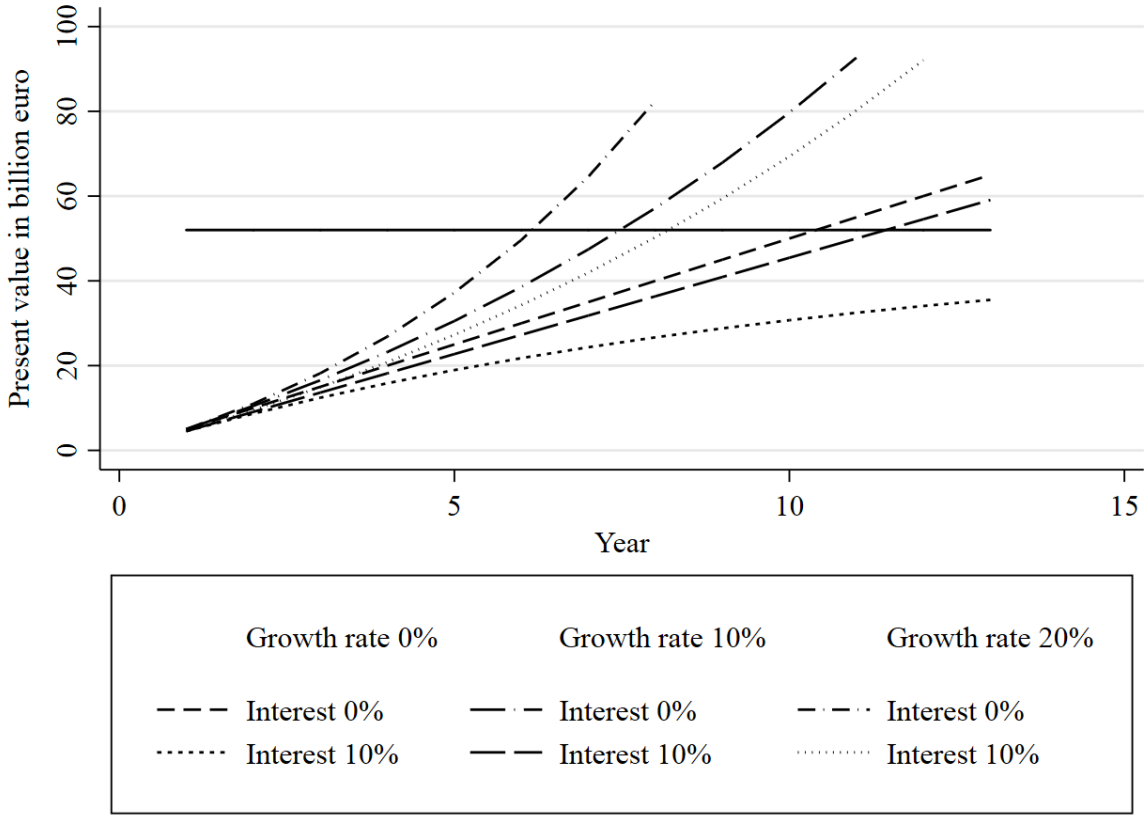
Notes: The table presents the results of the estimation model: $R_{it} = \alpha + \beta_1 Large_i + \beta_2 Digital_i + \beta_3 Event_t + \beta_4 Large_i * Digital_i + \beta_5 Large_i * Event_t + \beta_6 Digital_i * Event_t + \beta_7 Large_i * Digital_i * Event_t + e_{it}$. R_{it} is the return of firm i on day t. $Large_i$ is a dummy variable that identifies firms above the revenues threshold of 750 million euros. $Digital_i$ is a dummy variable that identifies all firms that can be classified as digital. The interaction term $Large_i * Digital_i$ identifies firms that are likely to fall in the scope of the "digital tax package". $Event_t$ is a dummy variable that takes the value of one in the event window and e_{it} is an error term. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading windows are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 44: Comparison of affected and non-affected firms in the pre-event period



Notes: The graphic is based on the results of estimating the regression model from equation (14): $R_{it} = \alpha + \beta_1 Large_i + \beta_2 Digital_i + \beta_3 Event_t + \beta_4 Large_i * Digital_i + \beta_5 Large_i * Event_t + \beta_6 Digital_i * Event_t + \beta_7 Large_i * Digital_i * Event_t + e_{it}$. R_{it} is the return of firm i on day t. $Large_i$ is a dummy variable set qual to 1 for firms above the revenues threshold of 750 million euros. $Digital_i$ is a dummy variable that identifies all firms that are likely to fall in the scope of the "digital tax package". $Event_t$ is a categorical variable that groups the firms' stock market returns into 26 bins relative to the event window. Each bin prior to the event window includes 10 trading days. The event window is from March 21 to March 22, 2018. The figure depicts the average abnormal return (β_7) of digital and large firms relative to all other firms over time. All coefficients are relative to the bin consisting of the eleven to 20 trading days before the event. We exclude the ten trading days immediately prior to the event date The vertical lines represent the 95 percent confidence intervals.

Appendix 45: Comparison of share value drop with expected revenue gains



Notes: The graphic depicts the expected present value of future tax revenue gains from the DST in comparison to the estimated market value drop in the event window. The present value of future tax revenues is calculated as $PV_0 = TaxRevenue_0 \times \sum_{t=1}^{T} \frac{(1+g)^t}{(1+r)^t}$, where g refers to the expected annual growth rate of tax revenue per year t and r to the discount rate. The vertical line represents the market value drop of 52 billion euros. In line with the European Commission's impact assessment, we assume for this back of the envelope calculation a revenue of 5 billion euros in the first year and assume different growth rates. We depict two different interest rate scenarios in this graphic: 10 percent and 0 percent. The interaction of the black vertical line and the revenue estimates indicates after how many years the additional tax revenues offset the initial market value drop.

Appendix 46: Alternative event dates

	(1) Stock return	(2) Stock return	(3) Stock return	(4) Stock return
Alpha	0.038*	0.045*	0.012	0.028
	(0.019)	(0.019)	(0.023)	(0.023)
Market return (S&P 1200)	0.732***	0.718***	0.787***	0.909***
	(0.054)	(0.050)	(0.047)	(0.044)
26-27 Feb. 2018	-0.148			
	(0.670)			
15-16 Mar. 2018		-0.300		
		(0.285)		
4-5 Dec. 2018			-0.017	
			(0.230)	
12-13 Mar. 2019				-1.275***
				(0.046)
Observations	53,692	53,716	52,734	52,320
Firms	222	222	222	222
Adj.-R2	0.058	0.057	0.102	0.120

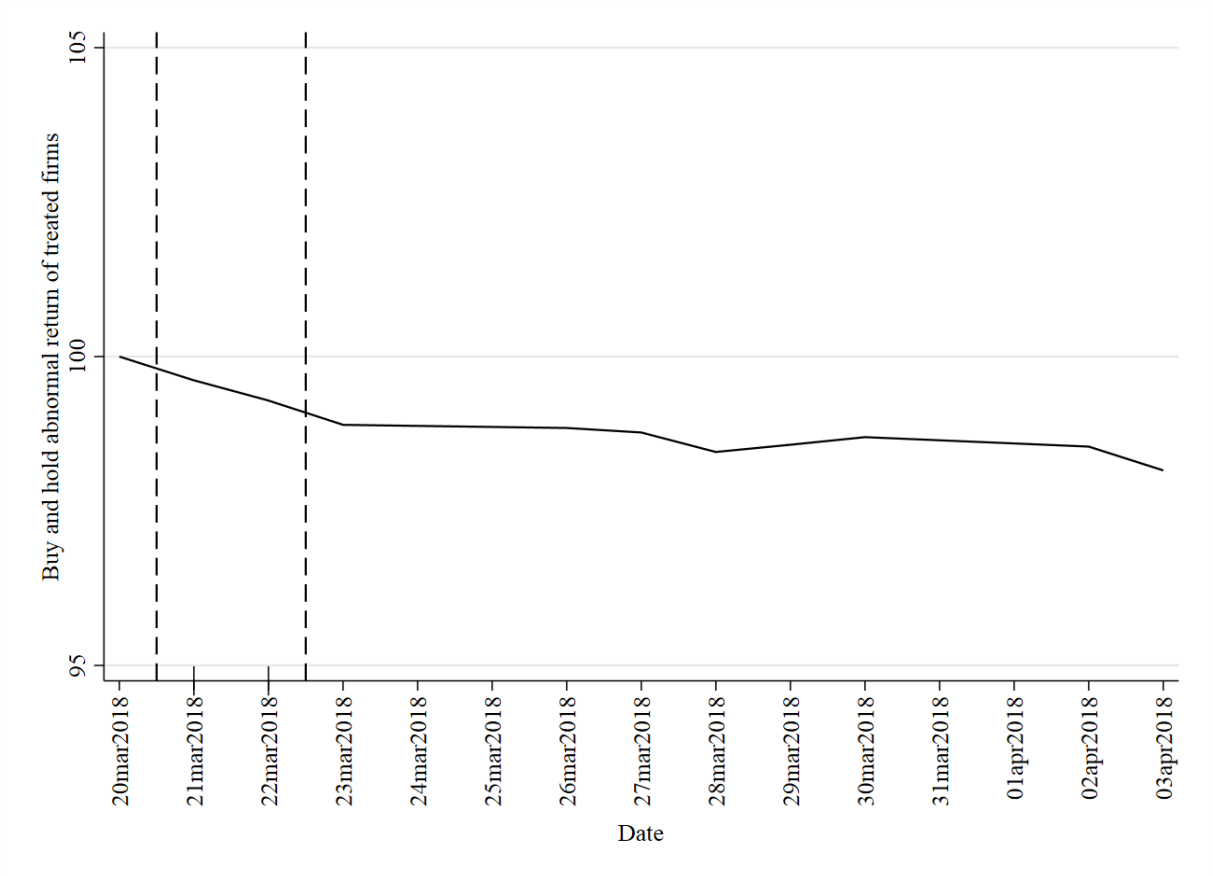
Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 222 treated firms and β is the estimate of the portfolio's market beta. The coefficient estimate of γ_i (and the corresponding standard error) is multiplied by two to account for the length of the two-day event window (Eckbo et al. 2007). γ can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the two-day event window. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 47: Alternative event dates – increased probability of trade-war

	(1) Stock return	(2) Stock return	(3) Stock return	(4) Stock return
Alpha	0.039**	0.042**	0.051***	0.037*
	(0.019)	(0.018)	(0.018)	(0.020)
Market return (S&P 1200)	0.747***	0.710***	0.703***	0.708***
	(0.056)	(0.044)	(0.043)	(0.042)
5-6 Mar. 2018	0.410			
	(0.718)			
18-19 Jun. 2018		-0.280		
		(0.651)		
2-3 Jul. 2018			0.098*	
			(0.051)	
17-18 Sep. 2018				-0.414
				(0.717)
Observations	53,700	53,454	53,400	53,070
Firms	222	222	222	222
Adj.-R2	0.060	0.069	0.065	0.068

Notes: The table presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma D_t + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal, R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. D_t is a dummy set equal to 1 in the two-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 222 treated firms and β is the estimate of the portfolio's market beta. The coefficient estimate of γ_i (and the corresponding standard error) is multiplied by two to account for the length of the two-day event window (Eckbo et al. 2007). γ can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the two-day event window. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. The event dates mark dates with peaks in a Google Trends Analysis on the key phrase 'trade war'. They match with announcements of the U.S. government or retaliation responses by affected governments. We exclude any event that is too close to our main event date (i.e. all events ten trading days prior and post to 21 Mar. 2018). Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

Appendix 48: Abnormal buy and hold return



Notes: The figure displays the abnormal buy and hold return of an equally-weighted portfolio of all potentially by the proposals affected firms. The figure is indexed to 100 on March 20, 2018. The scattered lines enclose our event window March 21 and March 22, 2018.

Appendix 49: Alternative event windows

	(1) Stock return	(2) Stock return
Alpha	0.044**	0.044**
	(0.019)	(0.019)
Market return (S&P 1200)	0.716***	0.718***
	(0.049)	(0.049)
20 Mar. 2018	0.167***	
	(0.041)	
21 Mar. 2018	-0.380***	
	(0.043)	
22 Mar. 2018	-0.310***	
	(0.059)	
20-22 Mar. 2018		-0.517
		(0.418)
Observations	53,946	53,946
Firms	222	222
Adj.-R2	0.062	0.062

Notes: Column (1) presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \sum_{d=-2}^{d=2} \gamma_d D_{dt}\, \gamma D_{dt} + e_{it}$. Column (2) presents the results of the conditional market model: $R_{it} = \alpha + \beta R_{mt} + \gamma_3 D_{3t} + e_{it}$. R_{it} is the return of firm *i* on day *t* that is likely to fall under the scope of the digital tax proposal (group of treated firms), R_{mt} is the return of the market index *m* (S&P Global 1200) on day *t*. In column (1) D_{dt} is a dummy set equal to 1 on the respective day. In column (2), D_{3t} is a dummy set equal to 1 in the three-day event window, and e_{it} is an error term. α provides an estimate for the alpha of an equally-weighted portfolio of all 222 treated firms and β is the estimate of the portfolio's market beta. In column (2), the coefficient estimate of γ_3 (and the corresponding standard error) is multiplied by three to account for the length of the three-day event window (Eckbo et al. 2007). γ_3 can thus be interpreted as an estimate for the cumulative average abnormal return *CAAR* over the three-day event window. The model is estimated using returns of 250 trading days before the event date, excluding the ten trading days immediately prior to the event date. Clustered standard errors by firm and trading days are in parenthesis. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

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