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## Internal Digitalization and Tax-efficient Decision Making

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# Internal Digitalization and Tax-efficient Decision Making

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## **Abstract:**

This paper investigates the effect of firms' internal digitalization on the performance of business support functions such as the tax department. We put forward a novel, micro-level IT sophistication index based on a survey monitoring European firms' digital infrastructure. Following the objective function of maximizing after-tax returns, we measure tax-efficient decisions in terms of minimizing the firm's worldwide tax burden. We show that internal digitalization boosts firms' ability to relocate income to tax-favored jurisdictions. We confirm this result using two plausibly exogenous shocks. First, we exploit a business software supply shock and provide evidence that the adoption of digital technologies enhances efficient cross-border tax planning. Second, using an event study design, we show that digitalized firms promptly adjust reported profits in response to income shifting incentive shocks. Overall, we show that digital infrastructure is a crucial foundation for timely, data-driven decision making and increases support functions' performance.

**JEL:** O33 L25 H25 H26 K34

**Keywords:** Digital Transformation, Digitalization, Firm Performance, Decision Making, Information Technology, Tax Planning

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## 1. Introduction

In this study, we analyze the effect of internal digitalization on the performance of firms' tax functions in terms of whether they make more efficient tax planning decisions. We define internal digitalization as the availability, accessibility and usage of sophisticated business software within a firm to monitor and manage internal business processes and operations. Importantly, internal digitalization resulting from investment in information technology (IT) is independent of the degree of digitalization of a firm's business model or distribution channel.<sup>1</sup>

This research is relevant for three reasons. First, the effect of internal digitalization on the performance of support functions such as the accounting and tax department is understudied. Second, elucidating the relation between internal digitalization and effective tax planning decisions provides new insights to the long-lasting debate on the IT productivity paradox (Brynjolfsson et al. 2017; Macdonald et al. 2000). While some studies show that investments in IT and data-driven decision making positively impact firm performance (Brynjolfsson et al. 2011; Melville et al. 2004; Hitt et al. 2002), other studies demonstrate that information systems do not necessarily affect firm performance (Li and Sandino 2018). Analyzing the effect of internal digitalization in multiple business functions can help uncover potential confounding factors to evaluate the underlying impact of IT investment on firm performance. Precisely, productivity measures are likely to be impaired to the extent that firms that progress internal digitalization report higher productivity in low-tax jurisdictions for tax reasons.

Third, our paper is a direct approach to evaluating how spillovers from internal digitalization on decision making disseminate within a firm.<sup>2</sup> Identifying these spillovers for decision making in business support functions complements existing research on the role of

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<sup>1</sup> For example, a steel manufacturer might have a better internal IT infrastructure than online retailers, social media networks or online search engines, which are commonly perceived as digital firms. In our perception, internal digitalization, i.e., firms' digital backbone, is a key driver of internal decision making.

<sup>2</sup> For indirect approaches to measure spillover effects of perceived IT-capacity on stakeholder decisions, see (Kim et al. 2018; Kohli et al. 2012; Kobelsky et al. 2008).

internal information quality (McGuire et al. 2018; Gallemore and Labro 2015) because it provides the major channel of why firms differ in their internal information quality.

Based on survey data on European firms' digital infrastructure, we are able to observe a firm's internal digitalization directly. We create a novel micro-level IT sophistication 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 provide us with a holistic picture of a firm's internal digitalization and are an enabler for advancements in digital technologies such as big data analytics. Essentially, our IT index is based on the most recent annual waves of an extensive European IT survey and reflects the degree of valuable internal digitalization at a more granular level than existing proxies for digitalization (Hershbein and Kahn 2018; Tambe et al. 2012; Bloom et al. 2012; 2016). We match the IT sophistication index with unconsolidated financial data of multinational corporations from ORBIS to obtain a rich panel of European multinationals.

We hypothesize that internal digitalization enables the tax department to monitor and manage global and complex value chains, business processes as well as internal capital markets more efficiently. As effective tax planning involves the decision rule of maximizing after-tax returns (Scholes et al. 2016), we analyze the performance of tax departments in terms of tax-motivated income shifting, which is considered the dominant method of tax departments to reduce a firm's worldwide tax burden and has an immediate positive effect on after-tax returns.

We study our hypothesis using three empirical strategies. First, we investigate the association between IT sophistication and the income shifting incentive sensitivity of reported profits according to the well-established Huizinga and Laeven (2008) profit shifting equation. The income shifting incentive indicates a firm's incentive to relocate income to tax-favored jurisdictions. We find evidence on cross-border income shifting only for internally digitalized firms. In contrast, firms without sophisticated digital infrastructure do not seem to exploit their

income shifting incentives efficiently. The positive association between internal digitalization and cross-border tax planning holds if we control for a number of observable firm characteristics, macro controls and a set of fixed effects. The coefficient estimate of our first empirical strategy indicates that an incremental increase in the level of internal digitalization increases the reactivity of reported profits to an income shifting incentive measure by 50 percent.

Second, we exploit a quasi-random shock to the level of internal digitalization, namely the introduction of a new business software solution package by the market leader SAP in 2009. The results of our generalized difference in difference analysis shed light on the effect of a new software solution package on cross-border tax planning activities of multinational corporations. We demonstrate a significant difference in the sensitivity of reported profits to the income shifting incentive between firms that adopt the software solution package and those that never introduce any software.

Third, we focus on plausibly exogenous changes in firms' income shifting incentive variable and how these translate to adjustments in reported profits for firms with high versus low internal digitalization. We find that firms with a higher IT sophistication index promptly adjust reported profits upwards in jurisdictions with large drops in the income shifting incentive. While our first identification approach provides interesting new insights into the correlation of internal digitalization and income shifting activity, the second and third approaches allow for a more causal interpretation of this relationship.

In an additional analysis, we find that firms with a higher level of internal digitalization that engage more actively in cross-border income shifting have more expenditures for tax consultants to back their tax planning strategies. Further cross-sectional analyses show that the relation between IT sophistication and income shifting is more pronounced for more complex, internationally dispersed multinationals and firms whose managers have accounting knowledge that helps them exploit the provided information for international income relocation. 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 and analyzing different tax planning channels of multinational corporations.

With this work, we contribute to the literature on the effects of information processing technologies on firm performance. First, we add to the IT productivity paradox (Li and Sandino 2018; Brynjolfsson et al. 2017; Macdonald et al. 2000), showing that the performance of business support functions increases with higher internal digitalization. Moreover, we provide a potential explanation of why previous literature finds mixed results on the effect of IT on firm performance, which is that reported profits of firms might be confounded due to tax planning incentives (Guvenen et al. 2017).

Second, our findings contribute to research on how information and the ability to generate meaningful knowledge from data improve decision making and can be a key competitive advantage (Aral et al. 2012; Brynjolfsson et al. 2011; Grover et al. 2018; Hitt et al. 2002; Janssen et al. 2017). Our results indicate that digital technologies do not only affect core business functions but that they also improve the performance of supporting functions. According to our investigation, internal digitalization turns out to be a key enabler of effective tax planning decisions. In this vein, our analysis is complementary to the findings of Gallemore and Labro (2015), McGuire et al. (2018), and Bilicka and Scur (2020), indicating that the income of firms with better information quality respectively more structured management practices is more responsive to tax avoidance and income shifting. However, we go beyond what is known so far by directly investigating firms' digital infrastructure as a crucial foundation for timely, data-driven income shifting decision making.

Third, we study IT sophistication as a mechanism to improve tax planning decisions in terms of a firm's ability to exploit income shifting incentives. Hence, we also contribute a novel explanation to the momentum-gaining debate on the extent and heterogeneity of tax-motivated

income shifting (Amberger and Osswald 2020; Blouin and Robinson 2019; Chen et al. 2019; De Simone et al. 2017; Markle 2016).

The structure of our analysis is as follows. In Chapter two, we outline a simple conceptual framework where firms that promote internal digitalization should, *ceteris paribus*, make better tax planning decisions. We develop an IT sophistication index and provide information on our data in chapter three. Chapter four presents the results for three different identification strategies. In chapter five, we conduct additional cross-sectional analyses and perform robustness tests. Chapter six concludes.

## **2. Conceptual Thoughts and Identification**

In this section, we sketch our conceptual thoughts on internal digitalization and tax decision making, derive the hypothesis for our empirical analysis and highlight our identification approaches.

It is reasonable to assume that all subsidiaries follow the objective function of after-tax profit maximization (Robinson et al. 2010; Scholes et al. 2016), which is achieved by tax minimization and production maximization. A multinational firm operates in different countries that plausibly differ in their tax rates, resulting in relatively high tax and low tax countries of operation. Following Scholes et al. (2016), the strategy of tax minimization and production maximization “requires the planner to consider the tax implications of a proposed transaction for all parties to the transaction.” In multinational groups with global operations, this endeavor may be highly complex and opaque. In addition, reallocation of global profits to low tax jurisdictions is costly (Hines and Rice 1994; Huizinga and Laeven 2008). Internal digitalization usage could help to reduce this complexity and make internal transfer prices, transactions, and capital flow better observable.

In this context, we draw on the insights of Brynjolfsson et al. (2011), who explain how more internal digitalization translates to better information and decision making. The authors demonstrate that the effective usage of IT 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, such as digital infrastructure, 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 IT implementation on the performance of core business operations (Li and Sandino 2018; Müller et al. 2018; Aral et al. 2012; McAfee 2002), it is still an open question whether the advantages of more advanced IT systems also materialize in better performance – commonly named the IT productivity paradox (Brynjolfsson et al. 2017; Macdonald et al. 2000). Furthermore, no evidence exists about the effect of internal digitalization beyond firms' core business operations on the performance of business supporting functions. In practice, IT systems are usually implemented as holistic solutions that connect operations with support functions such as the tax department.<sup>3</sup> In theory, this enhanced internal 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.

In order to analyze whether internal digitalization leads to better decision making in the tax department, we measure better decision making in terms of a firm's ability to exploit income shifting incentives by relocating income to tax-favored locations because this is directly linked to maximizing after-tax profits. Since internal digitalization enables a comprehensive view of the firm's operations and business processes, we hypothesize that firms with higher internal digitalization engage more actively in cross-border income shifting to increase firm profitability than firms without sophisticated IT.

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<sup>3</sup> For example, SAP, 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).

Conceptually, we expect better and timelier information on intra-group transactions to reduce the marginal costs of cross-border income shifting. This implies that for given marginal benefits of profit shifting, we should expect an increase in the share of shifted profits. The decision of a tax department to relocate income strategically could be a potential confounding factor to evaluate the underlying impact of IT investment on firm performance. Hence, elucidating the relation of profit-shifting and internal digitalization sheds light on how promised advantages of IT investments materialize (Guvenen et al. 2017; Macdonald et al. 2000). In principle, cross-border profit shifting can be achieved via three channels: transfer price adjustments, debt-shifting and location 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 if necessary. In a similar vein, better information on the current status of affiliates' financing situation that can be found in well-maintained databases provides opportunities for tax managers to suggest tax-efficient financing structures. Finally, groupware communication systems allow a close interaction and information exchange between members of the tax department and managers in cross-border operating sites to assess the value of intangibles and associated royalty payments. Since higher IT sophistication can be expected to facilitate all three income shifting strategies and to render them less costly, we focus on the outcome of income shifting in terms of tax sensitivity of reported profits.

To corroborate our hypothesis, we apply three empirical strategies. First, we investigate the association between IT sophistication and the tax incentive sensitivity of reported profits according to the well-known Huizinga and Laeven (2008) profit shifting equation. While this first approach provides interesting new insights into the correlation of IT sophistication and profit shifting activity, we enhance the analysis allowing for a more causal interpretation of this relationship.

Second, we exploit a quasi-random shock on firms' internal digitalization level, namely a major update on available business software systems in 2009. Precisely, we exploit the introduction of a new business software solution package in the middle of our sample period by the largest European ERP software provider.<sup>4</sup> We assume that the European firms in our sample adopt the newest business software version if they initially introduce an ERP software solution in the years subsequent to the new introduction.

Third, we focus on substantial changes in the tax incentive variable and how they translate to adjustments in reported profits for firms with high vs. low internal digitalization. Our setting of European affiliates is ideal for this approach as many European member states lowered their statutory tax rates during our sample period. Tax rate changes directly affect the income shifting incentive. A reduction in the income shifting incentive measure reduces the firm's incentive to decrease reported profits of affiliates in high-tax countries and vice versa for affiliates in low-tax countries, i.e., a reduction in the income shifting incentive measure has, in general, a positive effect on reported profits.

### **3. Measuring Internal Digitalization**

#### *3.1. Data and Sample*

We exploit the European Aberdeen computer intelligence and technology database (CiTDB) to identify firms' usage of sophisticated IT. The database comprises detailed and high-quality survey data on the use of IT and covers establishments across twenty European countries (Bloom et al. 2016). The Aberdeen Group, which maintains the CiTDB mainly to support sales and marketing decisions of IT goods 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

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<sup>4</sup> In May 2009, a leading provider of business software, the German SAP AG, released the SAP Business Suite 7. This product shifted the provider's focus from application silos to end-to-end business processes and combines different software solutions in a modular package. The software solution primarily targets large and complex enterprises (<https://news.sap.com/uk/2009/05/sap-business-suite-7-now-available-to-customers-worldwide/> (accessed: 11/27/2020)).

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 at least 100 employees are the most relevant firms for our cross-country empirical analysis. The US 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. 2012; 2014; 2016; Bresnahan et al. 2002; Brynjolfsson and Hitt 2003; Candel Haug et al. 2016; Forman et al. 2014; Mahr 2010; De Stefano et al. 2017). Yet, most of these prior studies use data that dates back at least ten years and focus on core IT equipment such as computers or IT staff. We are expanding previous literature by creating an IT index based on key software solutions that facilitate the use of state-of-the-art technologies such as big data management or real-time information exchange.

To evaluate the relation of the firm's digitalization degree and the performance of their non-core business functions, we enrich the Aberdeen dataset with detailed financial information. We use unconsolidated financial data and ownership information from the Bureau van Dijk's ORBIS database. 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 the Aberdeen CiTDB to the ORBIS database, based on unique firm names.<sup>5</sup> As we want to investigate the cross-border activities of multinational firms, we keep only affiliates in our sample that belong to an MNC. We keep all firms of an MNC for which we find at least one affiliate with a concordance. We define MNCs as a group of affiliates with more than 50 percent ownership chains and at least one cross-border relation. We use this sample to calculate an intra-group income shifting incentive variable ( $C$ ) for each MNC's affiliate. The variable  $C_{it}$  is the income shifting incentive measure, as defined by Huizinga and Laeven (2008).  $C$  is the

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<sup>5</sup> 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.

operating revenue (OPRE)-weighted average tax rate differential of each firm to all other group affiliates per year.<sup>6</sup>

The Aberdeen CiTDB contains survey responses for our variables of interest of up to 10 percent of their address pool per year. Hence, after calculating the intra-group income shifting incentive for each affiliate, we only keep affiliates for which we observe a direct CiTDB survey response.<sup>7</sup> We do so since anecdotal evidence suggests that the IT deployment can differ greatly between affiliates that belong to the same MNC.<sup>8</sup> In line with our empirical specification, we exclude loss-making affiliates and affiliates 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 groups. See Table 1 for an overview of the sample selection process and Table 2 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 (TAXUD) database, the Oxford Center for Business Taxation (CBT) tax database and the EY's Worldwide Corporate Tax Guides. Macro-level control data on the Gross Domestic Product (GDP), GDP per capita and unemployment rates are obtained from the World Bank's World Development Indicators database.

### 3.2. *IT Sophistication Index*

We develop a novel internal digitalization index – the IT sophistication index (IT index). For this reason, we combine the CiTDB survey responses on the usage of three different key software solutions to measure a firm's IT sophistication: 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

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<sup>6</sup>  $C_{it} = \frac{\sum_{k \neq i}^n OPRE_{kt} * (CIT_{it} - CIT_{kt})}{\sum_{k=1}^n OPRE_{kt}}$ , where  $i$ ,  $k$  and  $n$  are indicators for a firm, related affiliates and the total number of affiliates per group and year  $t$ , respectively.

<sup>7</sup> 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.

<sup>8</sup> Our anecdotal evidence relies on consultation with SAP staff on the usage of SAP solutions within multinational groups.

to the internal digitalization of firms along different dimensions and are therefore well suited 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 corporations plan and monitor procurement, production, invoicing, human resources and financial reporting. ERP systems have become increasingly important for all 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 data, data maintenance and interaction with the data (Connolly and Begg 2014). A rigorous 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. Hence, DBMS is the foundation for the tax department to have real-time views across the entire firm on affiliates, transactions, costs, products, and accounts that enable efficient transfer pricing strategies and intra-group transactions.

Groupware software enables close interaction and information exchange within an organization. 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 2020 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 corporation. Firms with an indicator value of three, i.e., using all software types, are classified as the most digitalized in our sample. The development of the IT index composition over time is shown in Figure 1. As one would expect, the number of firms with zero IT decreases over time while the number of firms with IT index values of two or three increases. In Figure 2, we graphically display the IT index composition across industries. The within-industry distribution of the IT 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.

## 4. Results

### 4.1. IT sophistication and Reported Profitability

#### 4.1.1. Descriptive Statistics and Results

Before moving to the regression results, we present descriptive statistics of our sample in Table 3. The full sample of 144,728 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 (2.5 million euro). On average, these firms have a revenue-weighted tax rate differential  $C$  of -0.001, representing a weak income shifting incentive to increase profits in the jurisdiction. The median income shifting incentive variable  $C$  is zero. Moreover, we show a correlation matrix for our sample variables in Table 4. The IT index is not systematically correlated with any observable firm characteristic. To further confirm that our findings will not be confounded by differences in the composition of the IT index groups, we show descriptive statistics per group in Table 5. 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 IT 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 material differences in the financial characteristics of the groups.

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 internal digitalization. Figure 3 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 IT 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  $C$ , 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.

Theory suggests that we should observe a clear negative association between RoA and  $C$ , 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 (Huizinga and Laeven 2008). We show that this negative association holds only for firms with internal digitalization. Digitalized firms have, on average, a lower RoA when  $C$  is negative and a higher RoA when  $C$  is positive. Thereby, firms in the highest IT index group show the steepest slope, followed by firms in the second-highest group and third-highest group. Interestingly, firms without internal digitalization even show a slight positive association between pre-tax profitability and  $C$ . This suggests that internal digitalization is a key factor for firms to observe the most profitable tax planning measures and make efficient decisions.

#### *4.1.2. Empirical Findings*

To measure the impact of internal digitalization on improved decision making in a firm's tax department, we employ the methodology of Hines and Rice (1994), later extended by Huizinga and Laeven (2008), which identifies MNCs' profit shifting activities. The model assumes that the total income of an affiliate is the sum of true profits, approximated by the Cobb-Douglas production function, and shifted profits. Extending the well-known production function with an income shifting incentive measure allows estimating the responsiveness of the total income to shifting activities. Higher responsiveness of reported profits to income shifting incentives indicates that digitalized firms can better monitor internal processes and communicate more productively. Hence, we analyze whether digitalized firms relocate income more efficiently. Exploiting this setting allows us to draw first insights on whether digitalized firms make more tax-efficient decisions.

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

$$\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 C_{it} + \beta_5 IT_{it} + \beta_6 C_{it} * IT_{it} + \beta_j X_{it} + \eta_t + \mu_{ind} + \vartheta_c + \varepsilon_{it}, \quad (1)$$

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).

$IT_{it}$  is the IT 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 internal digitalization.  $X_{it}$  is a vector of  $j$  firm-specific control variables. 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. Further, we include year fixed effects,  $\eta_t$  and individual industry fixed effects,  $\mu_{ind}$  or firm fixed effects  $\vartheta_c$ . Finally,  $\varepsilon_{it}$  is an error term. All variables are specified in Appendix 1.

Before testing our hypothesis, we replicate the basic Huizinga and Laeven (2008) regression to provide evidence on the well-established 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 6, which indicates that multinational corporations relocate income to low-tax jurisdictions. In terms of magnitude, our estimate of -0.516 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.

Column two to five in Table 6 provide the baseline results for the expected association between internal digitalization and cross-border tax planning. The coefficient of interest is the interaction of the income shifting incentive measure  $C$  and the IT index. We estimate an interaction coefficient of -0.240. The statistically significant coefficient implies that firms with an incrementally more sophisticated IT infrastructure exhibit a 0.240 percentage point stronger tax responsiveness of reported profits. Compared to our baseline estimate this translates to a 50 percent increase of tax-induced profit shifting per incremental improvement in the internal digitalization level. Figure 4 provides graphical evidence on the estimated profitability at different levels of IT sophistication for firms with different incentives to relocate income. The upper panel shows firms with no or only one software category available at the firm. The estimates indicate a moderate tax sensitivity of reported profits that is not statistically significant for firms without sophisticated software. As depicted in the lower panel, the profits of firms with more than two software categories at their site are more sensitive to the 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 IT sophistication index. As expected, the results remain stable if we include firm-fixed effects in our main estimation approach. The coefficient estimates are depicted in Column three of Table 6. Firm-fixed effects control for any remaining time invariant firm characteristics. Hence, our results indicate that the degree of internal

digitalization is an additional facilitator of cross-border tax planning, which goes beyond the mere size of multinationals or their business model.<sup>9</sup>

Moreover, we replace the IT sophistication measure with a dummy variable that takes the value of one if a firm has access to any software category. This variation of our IT index measure allows us to provide a clear-cut comparison between firms without any business software solution and firms that invest in internal digitalization. Columns four and five of Table 6 show that firms with business software solutions shift significantly more income. The estimate in column four indicates a combined semi-elasticity of -0.655 ( $0.154 + -0.809 = -0.655$ ). 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 6.55 percent. At the mean PLBT, this corresponds in absolute terms to an increase of reported profits in the jurisdiction by more than 500 thousand euro (from 8.528 million to 9.087 million euro).

Finally, to disentangle the different levels of our IT sophistication index more formally, we interact each index level separately with the income shifting incentive measure. We find a negative interaction coefficient for all index levels. The results are depicted in Table 7. 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.

#### 4.2. *Software Shock*

The results of our baseline estimation approach provide evidence on the association between internal digitalization and tax-induced profit shifting. To further link firms' level of internal digitalization with the efficiency of cross-border tax planning decisions, we exploit a plausibly

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<sup>9</sup> 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 chapter 5.

exogenous shock in the IT supply market. Specifically, we exploit the first release of a comprehensive business software solution bundle by the European market leader SAP in 2009.<sup>10</sup> One product of this 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 tax-decisions than firms that do not have access to an ERP system.<sup>11</sup> We estimate the following specification for the period 2005 to 2013:

$$\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 C_{it} * ERP\_update_t + \beta_5 C_{it} * ERP\_update_t * ERP\_introduction_i + \eta_t + \mu_{ind} + \varepsilon_{it}. \quad (2)$$

$ERP\_introduction_i$  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  $\beta_5$  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 5 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 version implementation, period 2005 to 2008, the tax-induced profit 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

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<sup>10</sup> 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).

<sup>11</sup> 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 are confident of capturing the intended relation. See <https://news.sap.com/2012/05/sap-named-worldwide-market-share-leader-for-enterprise-resource-planning/> (accessed: 11/26/2020).

coefficient estimate in the post period. Our regression results in Column one of Table 8 show that tax-induced profit shifting is, indeed, significantly stronger for treated firms after the release of a new business software solution package. These results shed light on the effect of the introduction of a new software solution on the cross-border tax planning activities of multinational corporations. It corroborates our hypothesis that internal digitalization improves tax-efficient decision making.

#### 4.3. Tax Incentive Shock

Next, to provide additional evidence for the effect of internal digitalization on cross-border tax planning, we exploit quasi-random shocks to the tax-induced income shifting incentive. The main determinant of the income shifting incentive measure is the tax rate differential between affiliates of a corporate group. Any statutory corporate income tax rate change has an immediate effect on the measure if the group has an affiliate 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 affiliate’s reported profits. Our sample of European multinationals 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:

$$\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 IT\_available_i + \beta_5 Post_t + \beta_6 IT\_available_i * Post_t + \beta_j X_{it} + \eta_t + \mu_{ind} + \varepsilon_{it}, \quad (3)$$

where  $IT\_available_i$  is a dummy variable that takes the value of one if a firm belongs to a group with access to sophisticated business software solutions, i.e., with an IT Index value above one,

and zero for firms in groups without sophisticated internal digitalization.  $Post_{it}$  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  $Post_{it}$  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 1) 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 (2020). To receive a conservative estimate for a group's IT sophistication, we assign the minimum IT index score per group to all firms within that group 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 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 an IT index value of zero.

Figure 6 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 firms without sophisticated software solutions. In response to the negative tax incentive shock, however, reported profits of firms with sophisticated software solutions 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 internal digitalization have the capabilities to quickly react to changes in external circumstances and tax-induced

incentives. Table 9 depicts the coefficient estimates of the regression analysis. In line with the graphical event study analysis, the statistically significant positive interaction coefficient indicates that firms with access to business software increase their reported profits after a large negative shock to the income shifting incentive more than firms without access to business software.

Overall, the combined results of our three empirical strategies provide new evidence on the relationship between internal digitalization and decision making performance in a firm's tax department. The first approach sheds light on the general association between internal digitalization and cross-border tax planning. Exploiting a shock to the level of internal digitalization and a shock to the income shifting incentive corroborates a more causal effect of firms' usage of sophisticated software on tax-efficient decision making in businesses' supporting functions. We enhance our findings and conclusions in the next chapter with additional associations, heterogeneity analyses and robustness tests.

## **5. Additional Analyses**

### *5.1. Payments to Tax Consultants*

In the previous chapter, we established that digitalized firms are able to observe and use income shifting opportunities more efficiently. In this regard, prior literature has identified that the utilization of tax consulting services is related to corporate tax planning (Wilde and Wilson 2018; Armstrong et al. 2012; Klassen et al. 2016). The services of external tax consultants with respect to income shifting include, for example, the 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.<sup>12</sup> 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 IT index and obtain consolidated financial information from the ORBIS database. As above, we use the smallest value of an affiliate's IT 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.<sup>13</sup> The sample consists of 5,468 group-years, with 875 unique groups. These groups have a mean IT 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:

$$\log(TaxFees_{jt}) = \beta_1 IT_{jt} + \beta_2 X_{jt} + \eta_t + \mu_{ind} + \varepsilon_{it}, \quad (4)$$

where the dependent variable is the natural logarithm of tax fees paid of group  $j$  in year  $t$ .  $IT_{jt}$  is the IT index on group-level and the variable of interest. A negative estimate of  $\beta_1$  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 ( $\eta_t$ ) and industry fixed effects ( $\mu_{ind}$ ) 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.

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<sup>12</sup> See Article 18 of Directive 2013/34/EU

<sup>13</sup> We manually inspect a randomized subsample to verify our approach.

We find a significant positive relation between internal digitalization and tax fees paid. Table 10 depicts the results. Using the IT index as a continuous measure, we find that an increase by one index category leads, on average, to 47% higher tax fees paid.<sup>14</sup> When using the IT 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 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.

## 5.2. *Cross-Sectional Analysis*

We conduct several cross-sectional tests to exploit different firm-characteristics and characteristics of firms' managers. First, the advantages of a high level of internal digitalization may be proportional to the complexity of a firm's structure. We proxy the complexity of a firm with its international dispersion, which we measure as the ratio of countries in which the group has affiliates over the group's total number of affiliates. Table 11 depicts the results. We provide evidence that the association between the income shifting incentive measure and IT sophistication is more relevant for internationally dispersed firms. I.e., the higher the international dispersion and the higher the degree of IT sophistication, the more negative is the association between reported income and the income shifting incentive measure to relocate income from high- to low-tax jurisdictions.

Second, we investigate if firms with dedicated accounting managers exploit the additional information from the sophisticated IT infrastructure better. We expect that firms with a specific accounting department can better process the obtained information and have a better knowledge

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<sup>14</sup> We verify our results using a Poisson pseudo-maximum-likelihood (PPML) specification (Silva and Tenreyro 2006; 2011). PPML specifications are used to deal with samples characterized by a large proportion of zero values of the dependent variable. Our untabulated result remains the same.

of how to relocate income in line with international regulations. We use information on managers from ORBIS to identify if a firm has an accounting manager. Columns three and four of Table 11 show the results of this analysis. As expected, firms with an accounting manager have a more negative tax sensitivity for their reported profits. This relation is even stronger if the firm has access to sophisticated IT infrastructure.

### *5.3. Robustness tests*

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

First, we replicate our main table with a non-interpolated index to control for any potential bias by our interpolation. The results are depicted in Table 12. 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.

Second, in Table 13, 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 Table 13 show that keeping the level of intangibles constant, we still find a significant negative coefficient for the interaction of the income shifting incentive variable  $C$  and our IT sophistication index. This confirms our evidence that firms with a digital infrastructure – independent of their use of intangible assets – tend to relocate income more aggressively.

Third, we replace the income shifting incentive variable.  $C$ , 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 Table 13 indicate that firms without sophisticated digital infrastructure do not seem to react to the CIT incentive. In contrast, firms with an IT sophistication 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 Table 13 focus only on the transfer pricing profit-shifting channel and indicate that firms with sophisticated IT 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.

## **6. Conclusion**

We investigate the effect of internal digitalization on the performance of firms' tax functions in terms of whether they make more effective cross-border tax planning decisions. Our study provides two key insights beyond the so far understudied evidence on the effect of internal digitalization on decision making in business support functions. First, we shed light on why previous literature finds mixed results on the effect of IT on firm performance. Reported profits of internally digitalized firms might be confounded due to cross-border income shifting incentives. Second, we investigate a direct channel for why firms differ in their internal information quality and complement existing studies on how spillovers from internal digitalization on decision making disseminate within a firm.

We create a novel micro-level IT sophistication index, based on survey data on the digital infrastructure of European firms, 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 corporations to maximize after-tax returns. This involves effective tax planning decisions by the tax department to minimize the global tax burden. We hypothesize that internal digitalization enables the tax department to monitor and manage global and complex value chains, business processes as well as internal capital markets more efficiently. Hence, we expect tax-motivated income shifting, which is considered the dominant method of tax departments to reduce a firm's worldwide tax burden, to be more pronounced for internally digitalized firms.

We study our hypothesis using three empirical strategies. First, we investigate the association between IT sophistication and the income shifting incentive sensitivity of reported profits according to the well-established Huizinga and Laeven (2009) profit shifting equation. Second, we exploit a quasi-random shock to the IT sophistication index, namely the introduction of a new business software solution package by the market leader SAP in 2009. Third, we focus on plausibly exogenous changes in firms' income shifting incentive variable and how these translate to adjustments in reported profits for firms with high versus low internal digitalization.

We show that if firms – digitalized and non-digitalized – have a high incentive to relocate income outwards, digitalized firms report relatively less profits in the jurisdiction and vice versa. The positive association between internal digitalization and cross-border tax planning holds if we control for a number of observable firm characteristics, macro controls and a set of fixed effects. Moreover, we demonstrate a significant difference in the sensitivity of reported profits to the income shifting incentive between firms that adopt a newly released software solution package and those that never introduce any software. Finally, we find that firms with a high internal digitalization level promptly adjust reported profits upwards in jurisdictions with large drops in the income shifting incentive. Overall, our identification approaches provide

interesting new insights into the correlation of internal digitalization and income shifting activity and hint at a causal interpretation of this relationship. The results are robust across several specifications, e.g., controlling for firms' usage of intellectual property or narrowing down the possible tax planning channels of multinational corporations.

Overall, our results provide new evidence on the association between internal digitalization and decision making in a firm's tax departments. We find that firms that employ sophisticated IT infrastructure make more efficient tax planning decisions. Digital infrastructure shows to be a crucial foundation for timely, data-driven decision making that extends even beyond core business functions to support functions such as the tax department.

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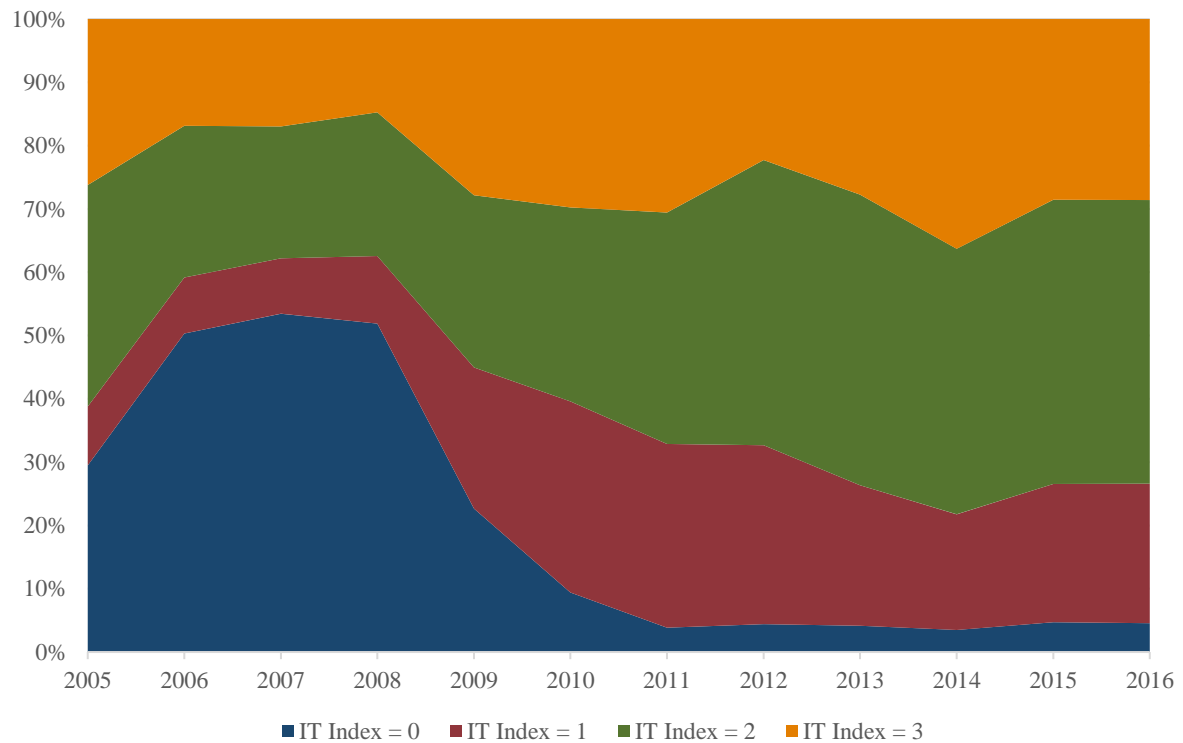
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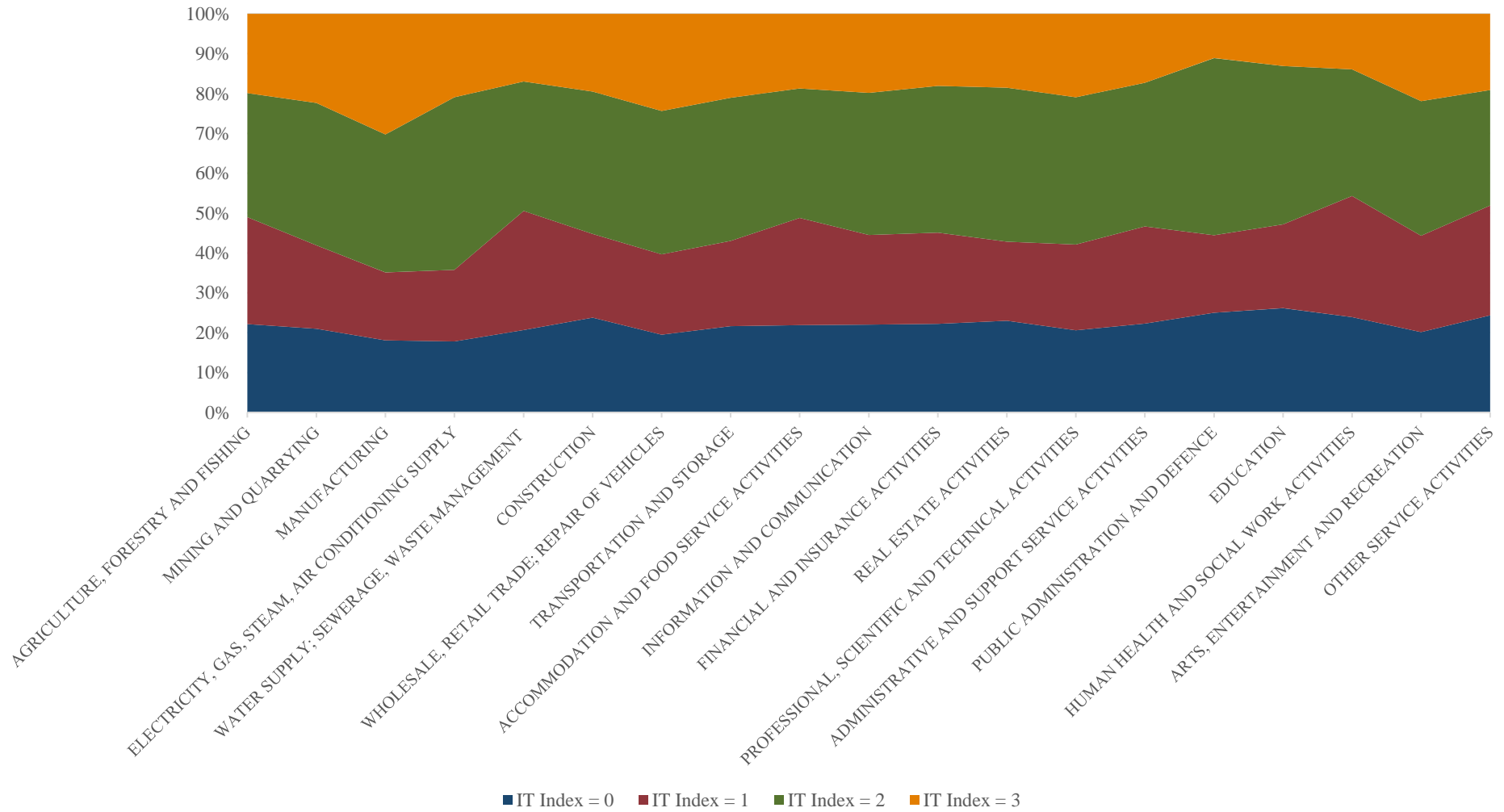
## FIGURES

**Figure 1: Index development over time**



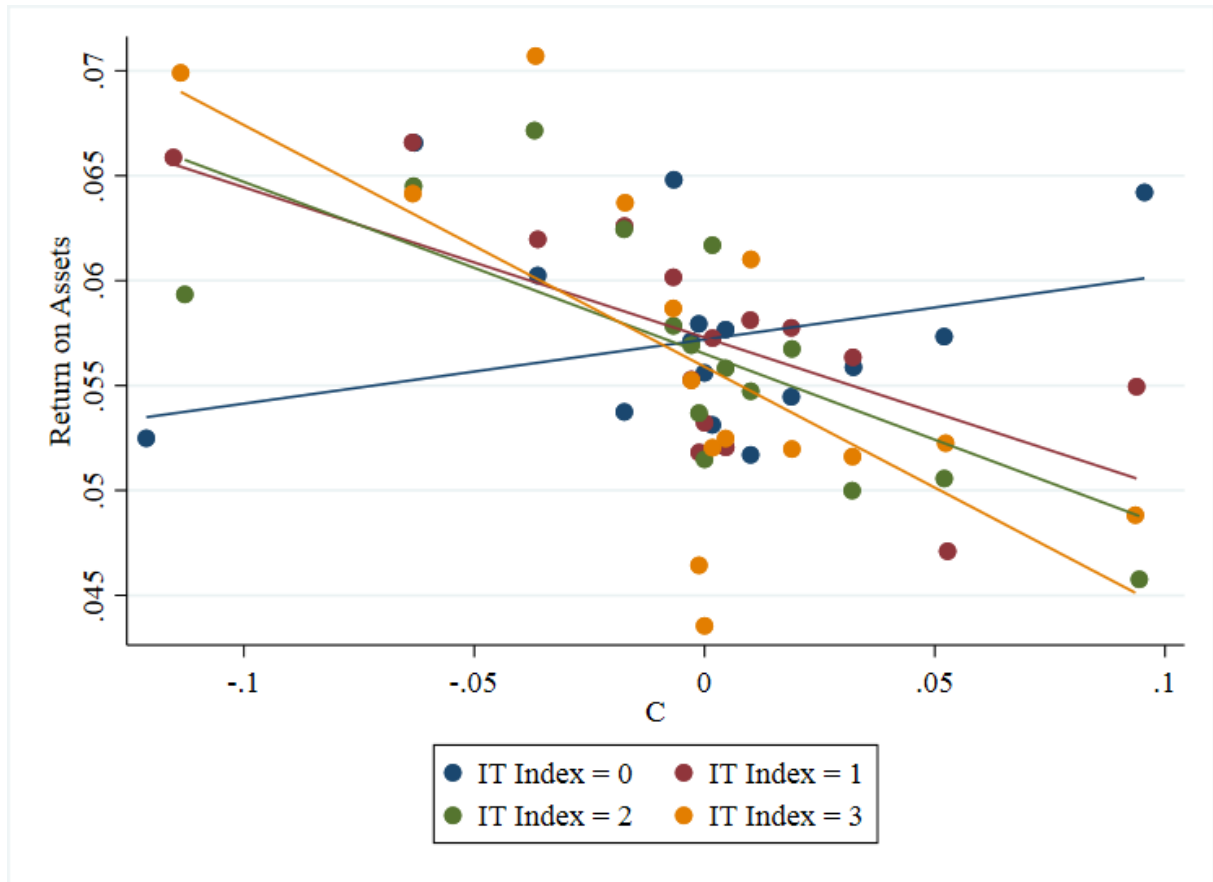
**Notes:** This figure shows the ratio of firms with a certain index value over time in our baseline sample. In total, the sample contains 144,796 firm-year observations. Over the complete sample period 28,455 firm-year observations have an IT Index value of 0; 28,290 firm-year observations have an IT Index value of 1; 51,093 firm-year observations have an IT Index value of 2 and 36,958 firm-year observations have an IT Index value of 3.

**Figure 2: IT Index distribution across industries**



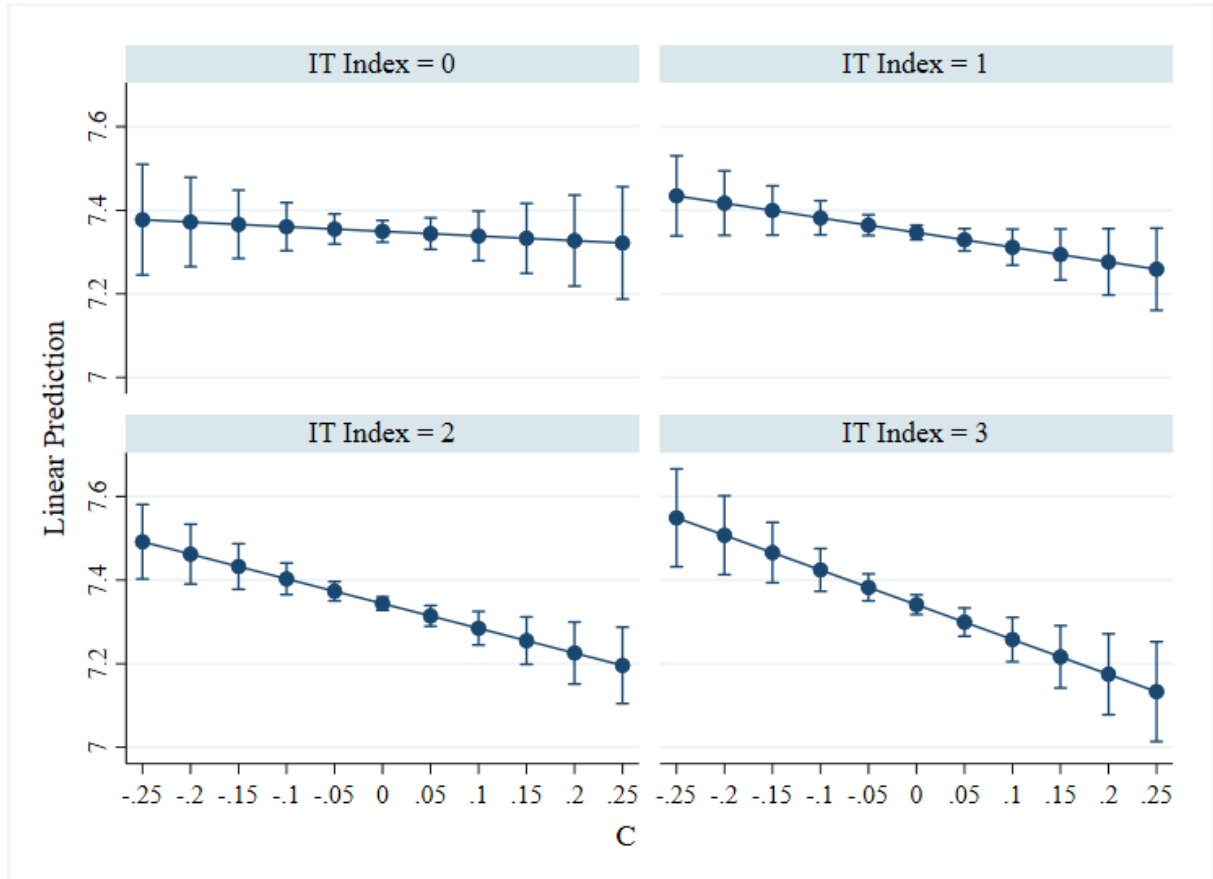
**Notes:** This figure shows the ratio of IT Index categories per two digit NACE industry.

**Figure 3: Descriptive Evidence – Binned scatterplot**



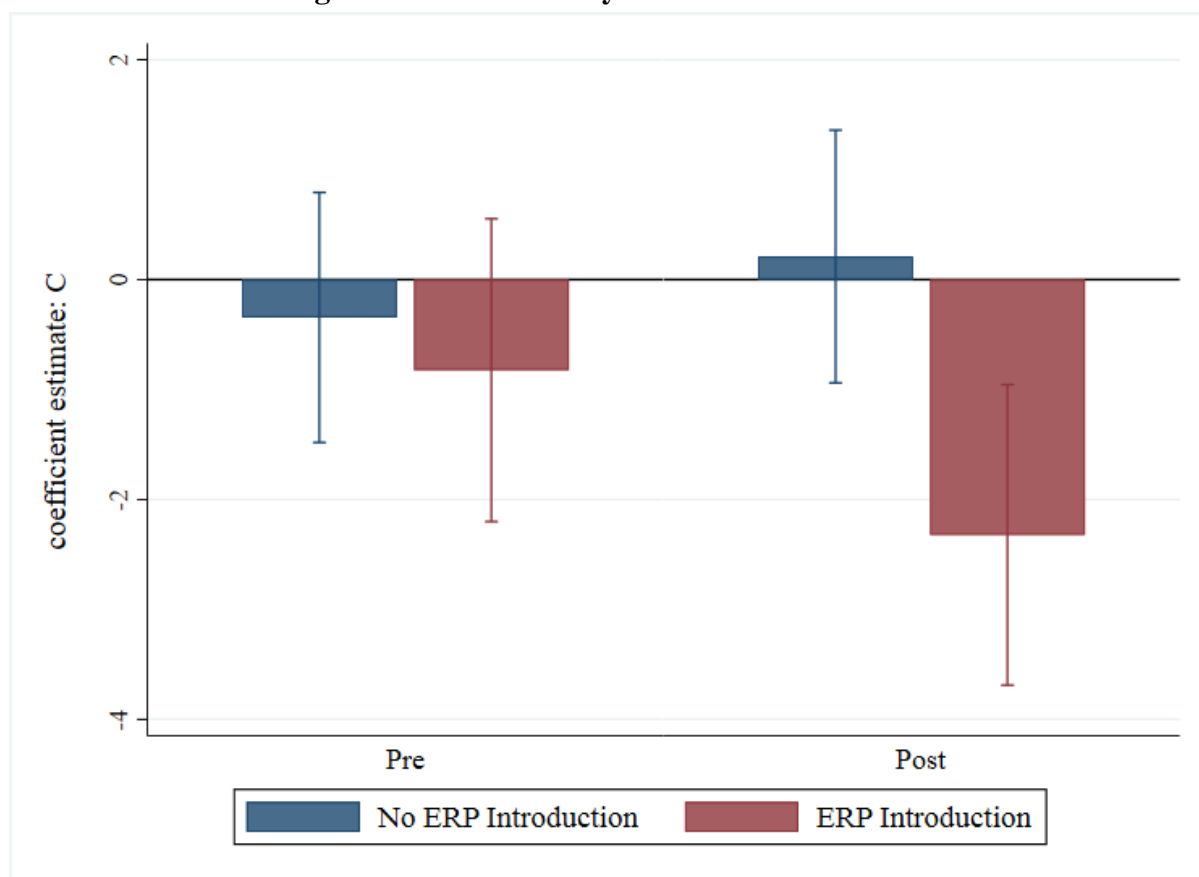
**Notes:** This figure shows a binned scatterplot. Firms at each digitalization level are grouped into 15 equally sized bins along the range of the  $C$ . The colored dots depict the average return on assets (in decimals) within each bin at the bin's average  $C$  value (in decimals) controlling for year- and industry fixed effects. Each color represents a different degree of digitalization. The plotted lines provide an estimate of the linear relation between the  $C$  and the return on assets. It controls for year- and industry-fixed effects.

**Figure 4: Tax sensitivity at different IT index levels**



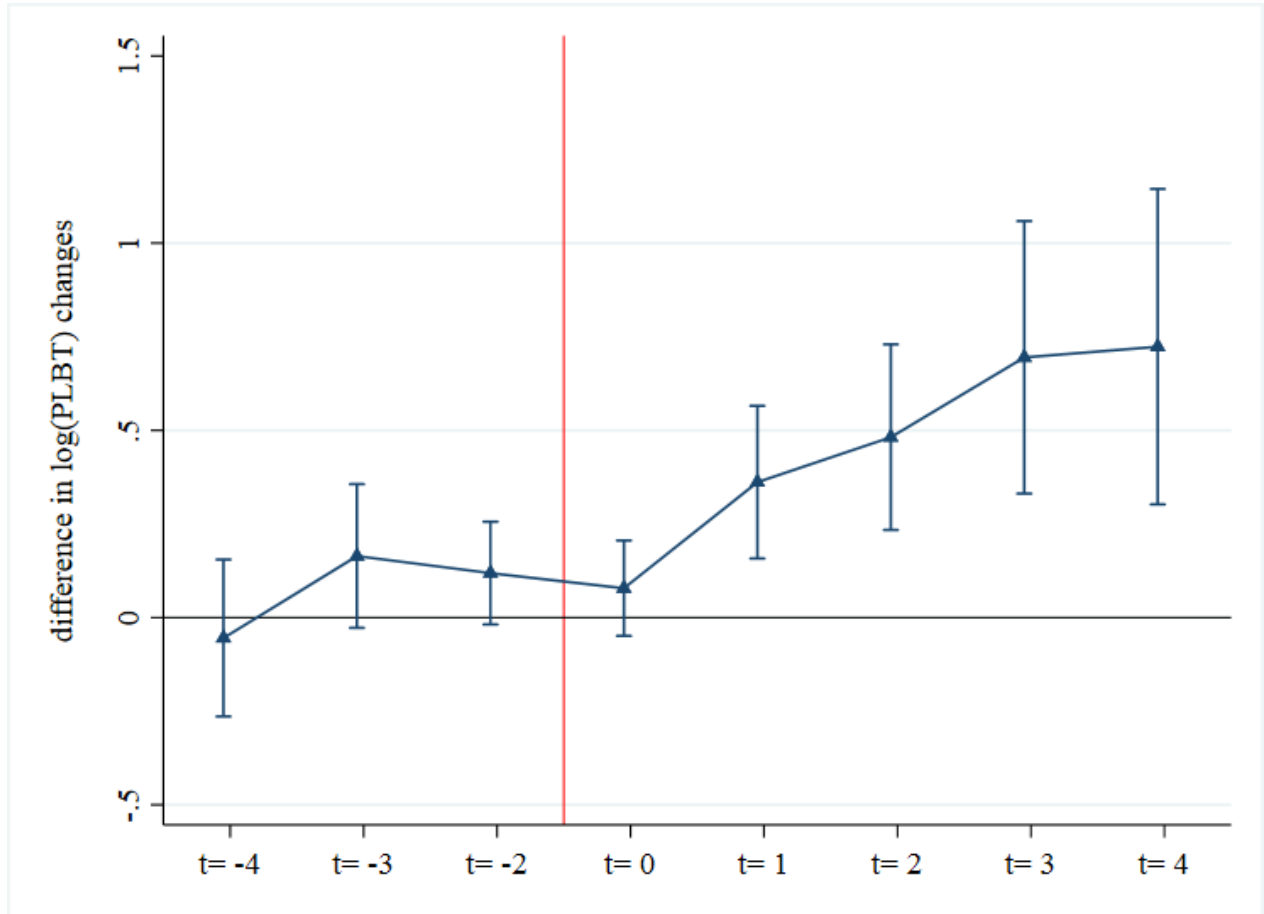
**Notes:** The figure depicts the predictive margins of the logarithm of PLBT over the C range for different levels of the IT Index, based on our baseline estimation approach:  $\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 C_{it} + \beta_5 IT_{it}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

**Figure 5: Tax sensitivity after ERP introduction**



**Notes:** In 2009, SAP, the largest European ERP provider, released an updated version. 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 vertical lines represent the 90% confidence intervals.

**Figure 6: Change in PLBT in response to negative income shifting incentive changes**



**Notes:** The figure depicts the difference in PLBT changes between digitalized and non-digitalized firms, for firms that experience a large negative change in our income shifting incentive measure (C). We classify large changes as those in the lowest decile of all firms for which we can determine a C. This analysis is based on a modified sample. The modified sample is based of all firms with CITDS survey responses and their affiliates. Affiliates within this group are classified as digitalized if the group has on average an IT Index value of above one and non-digitalized otherwise. The sample is than limited to firms that experience a C change in the lowest decile of C changes. 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 this year.

## TABLES

**Table 1: 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 (IT 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	-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.

**Table 2: Sample geographical dispersion**

<b>Country</b>	<b>firm-years</b>	<b>in percent</b>	<b>firms</b>	<b>in percent</b>
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	100	0.07%	13	0.05%
United Kingdom	17,264	11.92%	3,236	13.09%
<b>Total</b>	<b>144,795</b>		<b>24,715</b>	

**Notes:** The table depicts the country dispersion.

**Table 3: Descriptive Statistics**

<b>Variable</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>p25</b>	<b>Median</b>	<b>p75</b>	<b>Max</b>
EBIT	144,728	6,080	75,371	-11,928,418	526	1,566	4,372	8,055,006
PLBT	144,795	8,528	79,016	0	540	1,646	4,765	9,200,259
Total Assets	144,795	123,400	1,740,354	11	9,522	21,871	56,527	303,805,821
Tangible Fixed Assets (TFAS)	144,795	17,239	138,141	0	533	2,469	8,689	10,899,548
Employee Compensation (STAF)	144,795	12,955	265,206	0	2,713	5,500	11,481	96,241,793
Log(EBIT)	138,823	7.416	1.600	-3.244	6.426	7.435	8.432	15.902
Log(PLBT)	144,795	7.350	1.764	-6.908	6.292	7.406	8.469	16.035
Log(TFAS)	144,795	7.608	2.165	-6.908	6.279	7.812	9.070	16.204
Log(Employee Compensation)	144,795	8.622	1.200	-4.711	7.906	8.613	9.348	18.382
Productivity	144,795	0.053	0.027	-0.428	0.037	0.052	0.068	0.578
Log(GDP per Capita)	144,795	1.360	2.439	-8.075	0.459	1.663	2.552	25.163
Log(GDP)	144,795	8.491	4.227	2.493	5.723	7.719	9.400	26.094
Unemployment	144,795	1.728	12.847	-132.543	0.000	0.195	1.784	132.130
IT Index	144,795	1.667	1.061	0.000	1.000	2.000	3.000	3.000
C	144,795	-0.001	0.047	-0.262	-0.010	0.000	0.017	0.294
CIT	144,795	0.296	0.062	0.125	0.250	0.310	0.344	0.403

**Notes:** The table depicts the descriptive statistics of all relevant variables. All absolute financial values are stated in TEUR and the logarithm of it. Unemployment is stated in percent. The C and the CIT are stated in decimals.

**Table 4: Correlation Matrix**

	IT Index	Log (PLBT)	Log (Tangible Assets)	Log (Employee Compensation)	Log (Intangible Assets)	Log (GDP per Capita)	Log (GDP)	Unemployment	Income shifting incentive	Return on Assets
IT Index	1.0000									
Log (PLBT)	0.0575***	1.0000								
Log (TFAS)	0.0928***	0.4348***	1.0000							
Log (STAF)	0.0956***	0.5624***	0.5469***	1.0000						
Log (Intangible Assets)	0.0356***	0.3483***	0.3106***	0.4324***	1.0000					
Log (GDP per Capita)	-0.0516***	0.0599***	-0.1270***	0.0981***	0.1132***	1.0000				
Log (GDP)	-0.0585***	0.0810***	0.0255***	0.1666***	0.0894***	0.2247***	1.0000			
Unemployment	0.0822***	-0.0670***	0.0166***	-0.0445***	0.0007	-0.3557***	0.0562***	1.0000		
C	-0.0327***	-0.0017	-0.0273***	0.0555***	0.0038	0.1729***	0.3708***	0.1829***	1.0000	
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.

**Table 5: Descriptive Statistics – disentangled by IT Index category**

Variable	n	mean	sd	min	p25	median	p75	max
<b><u>IT Index = 0</u></b>								
Log(PLBT)	28,455	7.267	1.777	-6.908	6.201	7.313	8.381	15.902
Log(TFAS)	28,455	7.471	2.099	-6.908	6.232	7.653	8.858	16.102
Log(STAF)	28,455	8.513	1.210	-4.605	7.826	8.509	9.220	15.044
<b><u>IT Index = 1</u></b>								
Log(PLBT)	28,290	7.181	1.796	-6.908	6.117	7.241	8.308	15.777
Log(TFAS)	28,290	7.274	2.234	-6.908	5.890	7.463	8.791	16.204
Log(STAF)	28,290	8.462	1.250	-1.952	7.720	8.445	9.214	14.977
<b><u>IT Index = 2</u></b>								
Log(PLBT)	51,093	7.369	1.770	-4.423	6.295	7.412	8.479	16.035
Log(TFAS)	51,093	7.602	2.220	-6.215	6.224	7.810	9.108	15.799
Log(STAF)	51,093	8.634	1.197	-3.101	7.911	8.614	9.358	18.382
<b><u>IT Index = 3</u></b>								
Log(PLBT)	36,958	7.516	1.702	-2.263	6.509	7.584	8.621	15.499
Log(TFAS)	36,958	7.977	2.023	-6.908	6.755	8.205	9.336	14.743
Log(STAF)	36,958	8.809	1.128	-4.711	8.137	8.822	9.499	16.487

**Notes:** The table depicts the descriptive statistics of all relevant firm characteristics, disentangled by IT Index category.

**Table 6: Baseline results I**

Dependent Variable: Log(PLBT)

Panel 2005-2016

Variable	Baseline (1)	Continuous Interaction (2) (3)		Dummy Interaction (4) (5)	
C x IT Index		-0.240** (0.119)	-0.173* (0.092)		
C x IT available				-0.809*** (0.290)	-0.501** (0.240)
C	-0.516*** (0.177)	-0.111 (0.267)	0.330 (0.253)	0.154 (0.298)	0.437 (0.279)
IT Index		-0.003 (0.007)	0.004 (0.005)		
IT available				-0.002 (0.017)	-0.007 (0.012)
Log(TFAS)	0.156*** (0.006)	0.156*** (0.006)	0.041*** (0.007)	0.156*** (0.006)	0.041*** (0.007)
Log(STAF)	0.686*** (0.011)	0.686*** (0.011)	0.418*** (0.020)	0.686*** (0.011)	0.418*** (0.020)
Prod	4.468*** (0.346)	4.455*** (0.346)	8.718*** (0.276)	4.450*** (0.346)	8.717*** (0.276)
Log(GDP per Capita)	0.089*** (0.027)	0.090*** (0.027)	0.256 (0.346)	0.090*** (0.027)	0.262 (0.346)
Log(GDP)	0.007 (0.008)	0.007 (0.009)	-0.555* (0.330)	0.006 (0.008)	-0.559* (0.330)
Unemployment	-0.006*** (0.002)	-0.006*** (0.002)	-0.014*** (0.003)	-0.006*** (0.002)	-0.014*** (0.003)
Year Fixed Effects	x	x	x	x	x
Industry Fixed Effects	x	x		x	
Firm Fixed Effects			x		x
Observations	144,796	144,796	141,949	144,796	141,949
Number of firms	24,715	24,715	21,868	24,715	21,868
R2 (within)	0.349	0.349	0.043	0.349	0.043

**Notes:** This table presents the regression results for the baseline approach for 144,769 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 three include a novel measure for the digitalization of firms (IT Index). IT 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 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. 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.

**Table 7: Baseline results II – IT Index as categorical variable**

Dependent Variable: Log(PLBT)

Panel 2005-2016

Variable	Categorical interaction	
	(1)	(2)
C x IT Index = 1	-0.976*** (0.343)	-0.433 (0.280)
C x IT Index = 2	-0.564* (0.323)	-0.533** (0.268)
C x IT Index = 3	-1.023*** (0.364)	-0.534* (0.284)
C	0.153 (0.298)	0.450 (0.280)
IT Index = 1	-0.002 (0.018)	-0.020 (0.013)
IT Index = 2	0.004 (0.018)	0.003 (0.013)
IT Index = 3	-0.010 (0.020)	0.006 (0.015)
Log(TFAS)	0.156*** (0.006)	0.041*** (0.007)
Log(STAF)	0.686*** (0.011)	0.418*** (0.020)
Prod	4.448*** (0.346)	8.720*** (0.276)
Log(GDP per Capita)	0.089*** (0.027)	0.234 (0.346)
Log(GDP)	0.007 (0.009)	-0.533 (0.330)
Unemployment	-0.006*** (0.002)	-0.014*** (0.003)
Year Fixed Effects	x	x
Industry Fixed Effects	x	
Firm Fixed Effects		x
Observations	144,796	141,949
Number of firms	24,715	21,868
R2 (within)	0.349	0.043

**Notes:** This table presents the regression results for the baseline approach for 144,769 firm-years of European affiliates of multinational corporations. C is the income shifting incentive measure as defined by Huizinga and Laeven (2008). IT 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 and included in this regression 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.

**Table 8: Reactiveness of firms to digitalization shock**

Dependent Variable: Log(PLBT)

Panel 2005-2013

Variable	(1)	(2)
C x ERP update x ERP introduction	-2.393*** (0.797)	-1.347** (0.669)
C x ERP update	0.496 (0.531)	-0.452 (0.497)
C	-0.379 (0.422)	1.011** (0.444)
Log(TFAS)	0.172*** (0.012)	0.026** (0.013)
Log(STAF)	0.677*** (0.021)	0.419*** (0.040)
Prod	3.335*** (0.682)	8.244*** (0.552)
Log(GDP per Capita)	0.132** (0.056)	0.183 (0.708)
Log(GDP)	0.007 (0.018)	-0.192 (0.725)
Unemployment	-0.013*** (0.004)	-0.015*** (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)	0.331	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.

**Table 9: Reactiveness of firms to income shifting incentive shock**

Dependent Variable: Log(PLBT)

Panel 2005-2016

Variable	(1)	(2)
Post x IT available	0.128** (0.059)	0.049 (0.044)
Post	-0.055 (0.061)	0.035 (0.045)
IT available	0.095** (0.039)	-0.069** (0.028)
Log(TFAS)	0.171*** (0.008)	0.025*** (0.009)
Log(STAF)	0.656*** (0.012)	0.395*** (0.024)
Prod	4.627*** (0.539)	8.122*** (0.452)
Log(GDP per Capita)	-0.006 (0.034)	-0.192 (0.444)
Log(GDP)	0.038*** (0.015)	0.546 (0.430)
Unemployment	-0.005 (0.004)	0.008* (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)	0.490	0.047

**Notes:** This table presents the results for the reactivity of firm to a relatively large downward changes in the income shifting incentive variable C. IT available 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.

**Table 10: Analysis of additional compliance costs – Tax fees analysis**

Dependent Variable: Log(TAX Fees)

Panel 2009-2016

Variable	(1)	(2)	(4)
IT Index	0.47*** (0.16)		
IT Index = 1		0.40 (0.42)	
IT Index = 2		1.15** (0.46)	
IT Index = 3		1.21** (0.52)	
IT available group			0.79* (0.41)
PLBT	0.16 (0.30)	0.16 (0.30)	0.14 (0.31)
Log(Turnover)	0.93*** (0.31)	0.92*** (0.31)	0.94*** (0.31)
Log(Total Assets)	-0.04 (0.26)	-0.03 (0.26)	-0.05 (0.26)
Productivity	29.11*** (7.47)	28.86*** (7.48)	29.48*** (7.46)
Log(STAF)	-0.21 (0.24)	-0.21 (0.24)	-0.24 (0.24)
Log(GDP per Capita)	5.51*** (0.48)	5.49*** (0.48)	5.43*** (0.48)
Unemployment	-0.03 (0.05)	-0.03 (0.05)	-0.03 (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.

**Table 11: Cross-sectional analyses**

Dependent Variable: Log(PLBT)

Panel 2005-2016

Variable	Country dispersion		Accounting department	
	(1)	(2)	(3)	(4)
C x IT Index x Characteristic		-0.750** (0.381)		-0.275* (0.152)
C x Characteristic	-0.666 (0.774)		-0.743** (0.323)	
C	-0.105 (0.258)	-0.118 (0.267)	-0.139 (0.239)	-0.109 (0.269)
Characteristic	-0.609*** (0.031)		0.048*** (0.017)	
IT Index		-0.002 (0.007)		-0.001 (0.007)
C x IT Index		-0.073 (0.146)		-0.108 (0.140)
Log(TFAS)	0.161*** (0.006)	0.156*** (0.006)	0.156*** (0.006)	0.156*** (0.006)
Log(STAF)	0.663*** (0.011)	0.686*** (0.011)	0.686*** (0.012)	0.687*** (0.012)
Prod	4.484*** (0.344)	4.473*** (0.346)	4.383*** (0.350)	4.440*** (0.349)
Log(GDP per Capita)	0.074*** (0.027)	0.088*** (0.027)	0.085*** (0.027)	0.088*** (0.027)
Log(GDP)	-0.007 (0.008)	0.007 (0.009)	-0.002 (0.009)	0.004 (0.009)
Unemployment	-0.005** (0.002)	-0.006*** (0.002)	-0.007*** (0.002)	-0.006*** (0.002)
Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x	x	x	x
Observations	144,796	144,796	142,945	142,945
Number of firms	24,715	24,715	24,306	24,306
R2 (within)	0.357	0.349	0.348	0.348

**Notes:** This table presents the regression results for the Huizinga and Leaven (2008) income-shifting model for 144,769 (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. Column three includes a dummy that determines if a firm has a dedicated accounting manager. In columns two and four, the firm-specific characteristics are interacted with a novel measure for the digitalization of firms (IT Index). IT 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. 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.

**Table 12: Robustness I – Non-interpolated IT index**

Dependent Variable: Log(PLBT)

Panel 2005-2016

Variable	(1)	(2)	(3)
C	-0.276 (0.259)	0.024 (0.295)	0.026 (0.295)
IT Index	0.002 (0.007)		
IT Index = 1		-0.018 (0.021)	
IT Index = 2		0.005 (0.018)	
IT Index = 3		-0.001 (0.020)	
IT available			-0.002 (0.017)
C x IT Index	-0.194* (0.116)		
C x IT Index = 1		-1.132*** (0.389)	
C x IT Index = 2		-0.528 (0.322)	
C x IT Index = 3		-0.889** (0.359)	
C x IT available			-0.775*** (0.294)
Log(TFAS)	0.156*** (0.006)	0.156*** (0.006)	0.156*** (0.006)
Log(STAF)	0.684*** (0.012)	0.684*** (0.012)	0.684*** (0.012)
Prod	4.565*** (0.349)	4.556*** (0.349)	4.557*** (0.349)
Log(GDP per Capita)	0.099*** (0.027)	0.098*** (0.027)	0.099*** (0.027)
Log(GDP)	0.003 (0.008)	0.003 (0.008)	0.003 (0.008)
Unemployment	-0.005** (0.002)	-0.005** (0.002)	-0.005** (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)	0.350	0.350	0.350

**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 (IT Index). IT 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.

**Table 13: Robustness II – Alternative control and dependent variables**

Panel 2005-2016

Variable	<u>Controlling for intangibles</u>		<u>CIT as income shifting incentive</u>		<u>Log EBIT as dependent</u>	
	(1)	(2)	(3)	(4)	(5)	(6)
C	0.555* (0.312)	0.908*** (0.348)	-1.186*** (0.221)	-0.830*** (0.244)	-0.268 (0.248)	-0.046 (0.272)
IT Index	-0.016** (0.007)		0.015 (0.028)		-0.009 (0.006)	
IT Index = 1		0.007 (0.020)		0.271*** (0.082)		0.004 (0.016)
IT Index = 2		-0.006 (0.020)		0.121 (0.078)		-0.003 (0.016)
IT Index = 3		-0.042* (0.022)		0.135 (0.088)		-0.025 (0.018)
C x IT Index	-0.270** (0.135)		-0.059 (0.089)		-0.140 (0.108)	
C x IT Index = 1		-1.118*** (0.402)		-0.898*** (0.258)		-0.724** (0.315)
C x IT Index = 2		-0.827** (0.375)		-0.371 (0.244)		-0.380 (0.295)
C x IT Index = 3		-1.101*** (0.416)		-0.459* (0.276)		-0.656** (0.331)
Log(Intangible Assets)	0.055*** (0.004)	0.055*** (0.004)				
Log(TFAS)	0.150*** (0.007)	0.150*** (0.007)	0.155*** (0.006)	0.155*** (0.006)	0.173*** (0.006)	0.173*** (0.006)
Log(STAF)	0.690*** (0.014)	0.691*** (0.014)	0.689*** (0.011)	0.689*** (0.011)	0.687*** (0.010)	0.688*** (0.010)
Prod	5.202*** (0.379)	5.199*** (0.379)	3.712*** (0.346)	3.715*** (0.346)	4.911*** (0.312)	4.906*** (0.312)
Log(GDP per Capita)	-0.015 (0.030)	-0.016 (0.030)	0.101*** (0.027)	0.101*** (0.027)	-0.044* (0.024)	-0.045* (0.024)
Log(GDP)	-0.016* (0.009)	-0.015 (0.009)	0.037*** (0.010)	0.036*** (0.010)	0.003 (0.008)	0.003 (0.008)
Unemployment	-0.008*** (0.002)	-0.008*** (0.002)	0.000 (0.002)	0.000 (0.002)	0.001 (0.002)	0.001 (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)	0.369	0.369	0.348	0.348	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 (IT Index). IT 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.

### Appendix 1: Variable definition

Variable	Definition
EBIT	Earnings before interest and tax reported on the unconsolidated financial statements of firm <i>i</i> in year <i>t</i> .
PLBT	Pre-tax earnings on the unconsolidated financial statements of firm <i>i</i> in year <i>t</i> .
Total Assets	Total assets on the unconsolidated financial statements of firm <i>i</i> in year <i>t</i> .
Return on Assets (RoA)	Pre-tax earnings for firm <i>i</i> in year <i>t</i> scaled by total assets for firm <i>i</i> in year <i>t</i> .
Tangible Fixed Assets (TFAS)	Tangible fixed assets on the unconsolidated financial statements of firm <i>i</i> in year <i>t</i> .
Employee Compensation (STAF)	Compensation expense reported on the unconsolidated financial statements of firm <i>i</i> in year <i>t</i> .
Log(EBIT)	Natural logarithm of EBIT for firm <i>i</i> in year <i>t</i> .
Log(PLBT)	Natural logarithm of PLBT for firm <i>i</i> in year <i>t</i> .
Log(TFAS)	Natural logarithm of TFAS for firm <i>i</i> in year <i>t</i> .
Log(STAF)	Natural logarithm of STAF for firm <i>i</i> in year <i>t</i> .
Productivity (Prod)	The median return on assets measured on firm <i>i</i> 's country-industry level in year <i>t</i> , where industry refers to the two-digit NACE classification.
C	Intra-group income shifting incentive of firm <i>i</i> in year <i>t</i> , 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>i</i> , <i>k</i> and <i>n</i> are indicators for a firm, related affiliates and the total number of affiliates per group and year <i>t</i> , respectively.
IT Index (IT)	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>i</i> in year <i>t</i> .
IT available	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>i</i> in year <i>t</i> and zero otherwise. In Chapter 4.3 this variable is determined at the group level. I.e. it takes the value of one if the firm belongs to a group with access to one of the software categories.
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 takes the value of one in the periods after the shock to the income shifting incentive and zero otherwise.
Log(Tax Fees)	Natural logarithm of tax fees paid of group <i>j</i> in year <i>t</i> 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 <i>t</i> .
Log(Intangible Assets)	Natural logarithm of intangible assets for firm <i>i</i> in year <i>t</i> .
Log(GDP per Capita)	Natural logarithm of the per-capita GDP of firm <i>i</i> 's host country in year <i>t</i> .
Log(GDP)	Natural logarithm of the gross domestic product of firm <i>i</i> 's host country in year <i>t</i> .
Unemployment	The unemployment rate of firm <i>i</i> 's host country in year <i>t</i> .
CIT	The corporate income tax rate of firm <i>i</i> 's host country in year <i>t</i> .

Note: All variables used in chapter 5.1. are on the consolidated group level. Otherwise, the definitions remain the same.