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Internal Digitalization and Tax-efficient Decision Making

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Abstract:

Our study investigates firms' internal digitalization as a crucial foundation for timely, data-driven decision making. We evaluate the association between digital infrastructure and improved decision making in tax planning decisions to analyze if the benefits of digitalization expand beyond firms' core business functions. The novel use of a survey that identifies European firms' digital infrastructure over the period from 2005 to 2016 allows us to create an index of IT sophistication. Using this index, we extend prior approaches and observe the effectiveness of tax planning decisions in terms of a firm's ability to exploit income shifting incentives. Our empirical analysis confirms the prediction that digitalized firms respond more efficiently to income shifting incentives. Further, we provide evidence that firms with sophisticated IT are more reactive to shocks in the income shifting incentive than non-digital firms. Our results suggest that internal digitalization allows firms to efficiently monitor and manage internal processes and to strategically price internal transactions. With this work, we are the first to document the association of digitalization and the performance of firms' support functions.

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Keywords: Digital Transformation, Digitalization, Firm Performance, Decision Making, Multinational Corporations, Business Taxation, Information Technology, Profit Shifting

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1. Introduction

The intensive use of information technologies (IT) profoundly affects how firms produce and provide goods and services (Cardona et al. 2013; OECD 2015). However, not only the business models of multinational corporations (MNCs) become increasingly digital, also business processes, operations and the organization itself turn digital and transparent (Grover et al. 2018). In this paper, we investigate whether highly digitalized firms[1] make use of the abundance of data provided by digital infrastructure to improve the performance of their tax function in the sense that they take more effective tax planning decisions. We see this as an exemplary study shedding light on the question of how digital sourcing of intra-firm data affects decision making in integral parts of business functions.

Prior research has shown that investments in IT and data-driven decision making positively impact firm performance (Brynjolfsson et al., 2011; Hitt et al., 2002). However, it remains understudied whether improved decision making capabilities can also expand beyond firms' core business functions to support functions such as the tax department. We hypothesize that the use of sophisticated IT software, i.e., big data analytics, enables the tax department to monitor and manage global and complex value chains, business processes as well as internal capital markets more efficiently. To test our hypothesis, we focus on the relation between IT-sophistication and tax-motivated income shifting because efficient income shifting has an immediate positive effect on after-tax returns and effective tax planning involves the decision rule of maximizing after-tax returns (Scholes et al. 2016).

To observe firms' internal digitalization, we employ novel survey data on the digital infrastructure of European firms. We create a unique dataset by combining this survey with unconsolidated financial data of multinational corporations from ORBIS. In a similar vein as

[1] In our context, when we refer to digitalized firms, we mean firms that use sophisticated IT software to monitor and manage their internal business processes and operations.

Bloom et al. (2012, 2016), we develop an IT sophistication index to identify the extent of a firm's internal digitalization. Our IT sophistication index 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. Sophisticated IT infrastructure enables a comprehensive view of a firm's operations and business processes and allows to efficiently and effectively monitor and manage multinational groups.

Tax-motivated income shifting from high-tax to low-tax jurisdictions is considered the dominant method of tax departments to reduce the firm's worldwide tax burden. To observe income shifting, the well-established approach of Huizinga and Laeven (2008) examines the relation between affiliate reported pre-tax profit and the income shifting incentive. The income shifting incentive is a weighted average of an affiliate's tax rate differential to other affiliates within the corporate group.[2] Hence, a positive value indicates that an affiliate has incentives to relocate income to other affiliates while a negative value indicates that an affiliate attracts income of other group's affiliates. Consistent with prior literature, we find a negative relation between reported pre-tax profit and income shifting incentive. Considering a firm's internal digitalization, we hypothesize that firms with higher IT sophistication better observe their income shifting incentive and can adjust the tax-planning decisions accordingly. For this reason, we extend the approach of Huizinga and Laeven (2008) by our IT sophistication index.

Our initial graphical binned scatter analysis directly shows that within the group of firms that have a high incentive to shift income outwards, firms with high software sophistication report a relatively lower average profitability and vice versa. However, if firms have no incentive to relocate income, the level of software sophistication is irrelevant for firms' average profitability. This suggests that firms with higher IT sophistication exploit their income shifting

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[2] See chapter 3.3. for a detailed description of the calculation and meaning of the income shifting incentive variable.

incentives more efficiently. Coherently, plotted regression lines for each group of IT sophistication indicate that the expected negative association between the income shifting incentive and firm profitability only exists for digitalized firms. The profitability of multinationals without sophisticated software seems to be relatively insensitive to the income shifting incentive measure.

Regression analyses further corroborate these findings. The coefficient of interest is the interaction of the income shifting incentive variable and the IT sophistication index. We estimate an interaction coefficient of -0.240. The statistically significant coefficient implies that firms with more sophisticated IT infrastructure exhibit a stronger tax responsiveness of reported profits than firms without this infrastructure.

Furthermore, we find that the found relation between IT sophistication and tax planning is even more pronounced for internationally dispersed firms. This finding makes sense as we expect those firms to be even more opaque. We also find a stronger relation for firms whose managers have accounting knowledge that helps them to exploit the provided information for international income relocation.

To further strengthen our findings, we follow an alternative identification strategy and exploit quasi-random shocks to the income shifting incentive variable. As the income shifting incentive variable is a dynamic measure of the differential in corporate income tax rates a MNC faces in its jurisdictions of operations, we use this dynamic and look at large changes to the incentive variable caused by potentially exogenous corporate income tax rate changes. We expect that firms with a higher IT sophistication index are able to better observe the tax rate differentials and, thus, are more reactive to shocks in the incentive measure. Our results confirm this prediction. 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 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. 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.

To the best of our knowledge, our study is the first to focus on the technological abilities of multinational firms to monitor and manage internal processes of non-core business functions and to price internal transactions strategically. As Brynjolfsson and McElheran (2016) argue, firms with a more sophisticated digital infrastructure have more information to draw on, enabling a more holistic view of a group's financial performance. Transferring this argument into the context of tax-related decision making, we agree with Scholes et al. (2016) that "effective tax planning requires the planner to consider the tax implications of a proposed transaction for all parties to the transaction. This is a global or multilateral, rather than a unilateral, approach". Hence, digital infrastructure turns out to be a key enabler of effective tax planning decisions. In this vein, our analysis adds to the findings of Gallemore and Labro (2015) and McGuire et al. (2018), indicating that the income of firms with better information quality is more responsive to tax avoidance and income shifting. We go beyond what is known so far by investigating firms' digital infrastructure as a crucial foundation for timely, data-driven decision making. Exemplarily, we evaluate the association between IT sophistication and improved decision making in tax planning decisions. According to Scholes et al. (2016), "effective tax planning involves considering the role of taxes when implementing the decision rule of maximizing after-tax returns." In this regard, we evaluate the effectiveness of tax planning decisions in terms of a firm's ability to exploit income shifting incentives. Hence, we also contribute to the momentum gaining debate on the extent and determinants 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. Chapter two provides the conceptual framework and develops our hypothesis. The third chapter lays out our data. Moreover, we develop an IT sophistication index and explain our methodological approach. In chapter four, we present our results and robustness tests. Chapter five concludes.

2. Conceptual framework and hypothesis development

Back in the day, firms' internal digitalization began with the usage of telephones, which allowed firms to expand their business activities across multiple locations (Hardy 1980). Later, personal computers were available to firms that performed basic calculations and stored data. Nowadays, internal digitalization has become a key value driver. An extensive pool of IT[3] is available to firms that, for example, automate operations, integrate and streamline processes or enable communication without borders and that reach from customer relationship management over production planning to forecasting financials. Simultaneously, the amount of available data that is available, both from internal processes and external stakeholders, and can be exploited by firms has outgrown any imaginable scale (McAfee and Brynjolfsson 2012). Thus, firms that promote internal digitalization and use the potential of IT should, ceteris paribus, be able to make better decisions, create a competitive advantage and ultimately increase firm value.

Bryjolfsson et al. (2011) provide an overview of the theory of the relation between IT, better information and decision making. The authors demonstrate that the effective usage of IT

[3] We follow Whisler & Leavitt, (1958) loosely and define IT as a system that rapidly processes large amounts of data and applies statistical and mathematical methods to support decision making. We also consider systems that enable the organization and communication of geographically dispersed groups of people as 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 potential results (Brynjolfsson et al. 2011). In addition, firms with sophisticated information processing techniques, such as digital infrastructure, are able to convert information into value at lower costs and with greater efficiency (Brynjolfsson et al. 2011; Galbraith 1974).

Other research evaluates the effect of IT implementation on the performance of core business operations. Among others, Hitt et al. (2002) find a positive association between the adoption of an enterprise resource planning (ERP) system and profit margins, return on assets and other key performance indicators. The availability of an ERP system seems to be essential for improved decision making at the operational unit (Aral et al. 2012; McAfee 2002). Furthermore, prior literature shows that discovering valuable knowledge in databases, i.e., implementing big data analytics, can improve businesses' efficiency, effectiveness, and productivity (Fayyad et al. 1996; Grover et al. 2018). Thereby, the positive impact of big data analytics on decision making quality depends on a firm's capabilities to integrate big data analytics into the existing process, the existence of highly skilled employees to handle the data and technical systems to store and process the data (Janssen et al. 2017). A recent study of 814 firms that use big data analytics indicates that the productivity of these firms is positively associated with their big data analytics capabilities (Müller et al. 2018).

So far, research has provided evidence that the core business operations gain from the implementation of IT. However, it remains understudied whether the advantages also expand beyond firms' core business operations. McAfee (2002) protocols, for example, that an ERP adoption at the operational level does not elicit major changes to a firm's general technological infrastructure or business processes. However, since IT systems are often implemented as holistic solutions[4] that connect operations with support functions, an increase in a firm's IT sophistication should also improve decision making in support functions such as the tax department. Ultimately, the accuracy of this theory may be an empirical question.

One of the objectives of the tax department is to maximize firm value by exploiting tax planning opportunities (Robinson et al. 2010). Following Scholes et al. (2016), this "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. IT usage could help reduce this complexity and make internal transfer prices, transactions, or capital flow better observable. In other words, and in line with Brynjolfsson et al. (2011), the usage of sophisticated IT might increase the information quality within the tax department[5], improve processes between affiliated tax departments and, finally, lead to more successful decision making.

Generally, in the context of business taxation, better decision making is associated with the maximization of after-tax profits (Robinson et al. 2010; Scholes et al. 2016). In order to analyze whether the usage of sophisticated IT 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 since this is directly linked to maximizing after-tax profits. This rationale leads to our first hypothesis:

H1: Reported profits are more sensitive to an income shifting incentive for firms with a pronounced digital infrastructure than for firms without sophisticated IT.

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[4] 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).

[5] In prior studies, McGuire et al. (2018) and Gallemore and Labro (2015) examine the relationship between the quality of internal information and tax planning. They find that higher internal information quality enables firms to engage in greater tax avoidance or shift more income.

Overall, internal digitalization enables a comprehensive view of the firm's operations and business processes and allows to efficiently and effectively monitor and manage multinational groups. IT seems to have a positive impact on the decision making and performance of firms' core operations. However, it is unclear whether the improved decision making capabilities also expand to support functions such as the tax department. To corroborate our first hypothesis and shed light on the effects of the digital transformation on business support functions, we test whether firms with detailed knowledge of their global activities react more directly to large shocks to the income shifting incentive measure.

H2: In contrast to less digitalized firms, firms with sophisticated IT software directly adjust their reported profits in response to changes in the income shifting incentive.

3. Identifying digital technology and estimation approach

3.1. Data and sample

We exploit the Aberdeen computer intelligence and technology database (CiTDB) to identify firms' usage of sophisticated IT. The database comprises detailed survey data on the use of IT and covers establishments across twenty European countries. 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 software usage. The CiTDB data 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 empirical analysis. 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 U.S. data that dates back at least ten years. Our European Aberdeen CiTDB survey panel covers the years 2005 through 2016. To evaluate the relation of the firm's digitalization degree and the performance of their non-core business functions, it is necessary to enhance 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.[6] As we want to investigate the cross-border activities of multinational firms, we keep only affiliates in our sample that belong to a MNC. We keep all firms of a 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-Index) for each MNC's affiliate.[7]

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 CiTDB survey response.[8] We do so since anecdotal evidence suggests that the IT deployment can be very different between affiliates that belong to the same MNC.[9] In line with our empirical specification, we exclude loss-making affiliates and exclude 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.

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[6] 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.

[7] See chapter 3.3. for a detailed description of the calculation and meaning of the income shifting incentive variable (C-Index).

[8] 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.

[9] Our anecdotal evidence relies on consultation with SAP staff on the usage of SAP solutions within multinational groups.

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. Measuring digitalization at the micro-level

We develop a novel internal digitalization index – the IT sophistication index (IT index). Our IT index captures firms' access to key software solutions. This stays in contrast to earlier studies that have only relied on the ratio of personal computers (PCs) to total employees as a measure of IT intensity (Bloom et al. 2012; Forman 2005; Hershbein and Kahn 2018).

In light of the significant digital and technological developments over the last decade, the ratio of personal computers per employee no longer seems sufficient to measure firms' degree of digitalization. The costs for personal computers have plummeted and the number of PCs at a site can easily outgrow the number of employees. To benefit from the era of digitalization, firms rather have to connect information, link processes and automate workflows. These capabilities require the usage of sophisticated software solutions. Recent studies have already tried to capture this dimension of digitalization by using the availability of different software types, provided by the CiTDB survey, as a proxy for the level of a firm's degree of digitalization (Bloom et al. 2014; 2016; Candel Haug et al. 2016).

We combine the CiTDB survey responses to the questions 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. These software solutions contribute 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 a value creation process. Core features of the system usually help corporations to plan and monitor procurement, production, invoicing, human resources and financial reporting. ERP systems become increasingly important for all kinds of business models and are essential for the digitalization process of corporations (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.

Database management systems provide access to databases. They 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. A structured data collection and the pre-processing of data is also at the core of data mining processes (Fayyad et al. 1996; Hand et al. 2000).

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.

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 at all in the firm, to three, the firm uses all software categories. Table 3 provides an overview of the dispersion of categories in our sample.[10] 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.

3.3. Methodology

To measure the impact of 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 and shifted profits. While true profits are empirically impossible to observe, the model approximates the true income with the help of the traditional Cobb-Douglas production function as the return to invested capital, labor and productivity. This function is expanded by an income shifting incentive measure to estimate the responsiveness of the total income to shifting activities. The income shifting incentive measure is determined through the affiliate specific tax rate differential (Huizinga and Laeven 2008). Since digitalized firms can better monitor internal processes and communicate more productively, they should also better observe their available incentives to shift income for tax purposes. Hence, we analyze whether digitalized firms relocate income more efficiently.

[10] We interpolate the IT sophistication index to account for years in which the firm was not part of the survey wave. Results remain robust if a non-interpolated IT sophistication index is used.

Exploiting this setting allows us to draw conclusions on whether digitalized firms make more tax-efficient decisions.

The model is commonly applied in the profit shifting literature and 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 follow this literature and enhance the model with a measure for firms' level of IT sophistication:

$$\log(PLBT_{it}) = \beta_1 \log(TFAS)_{it} + \beta_2 \log(STAF)_{it} + \beta_3 \log(Prod)_{it} + \beta_4 \mathrm{C}_{it} + \beta_5 \mathrm{D}_{it} + \beta_6 \mathrm{C}_{it} * \mathrm{D}_{it} + \beta_j \mathrm{X}_{it} + \eta_t + \mu_{ind} + \vartheta_c + \varepsilon_{it}\ , \qquad (1)$$

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 contrast to earnings before income and taxes (EBIT), PLBT captures profit shifting via transfer pricing and intracompany financing decisions. We do not limit our analysis to a specific profit shifting channel as a sophisticated digital infrastructure can increase firms' abilities to relocate income in multiple dimensions.

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 (Amberger and Osswald 2020; De Simone et al. 2017; Markle 2016).

The variable C_{it} is the income shifting incentive measure, as defined by Huizinga and Laeven (2008). The *C-Index* is the operating revenue (OPRE)-weighted average tax rate differential, of each firm to all other affiliates of a group, per year:

$$C\text{-}Index_i = \frac{\sum_{k \neq i}^{n} OPRE_k * (CIT_i - CIT_k)}{\sum_{k=1}^{n} OPRE_k}, \qquad (2)$$

where *i*, *k* and *n* are indicators for a firm, related affiliates and the total number of affiliates per group and year, respectively. The variable OPRE is the operating revenue of the group's affiliates and CIT_i (CIT_k) is the effective corporate income tax rate applicable to a firm (related firms). A positive value of the C-Index indicates that a firm has incentives to relocate profits to other affiliates while a negative value indicates that an entity attracts profits of other group's affiliates. By construction, the average C-Index of all affiliates of a MNC is zero. In robustness tests, we also use the CIT as an alternative income shifting incentive measure.

D_{it} is the IT sophistication index. The variable can range from zero to three. 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. We expect β_6, our coefficient of interest, to be negative. A significant coefficient on the interaction term $\mathrm{C}_{it} * \mathrm{D}_{it}$ provides evidence that firms with sophisticated software respond differently to the income shifting incentive measure than less digitalized firms. In additional analyses, we include firm- and manager-characteristics to provide evidence on cross-sectional variation in an alternative specification.

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 affiliate's host country. Our regression includes a number of fixed effects. We include individual industry fixed effects, μ_{ind}, to control for any unobservable systematic differences between different industries and we include year fixed effects, η_t, to eliminate general economic shocks or any other time-trends unrelated to our research question. This specification maintains cross-sectional variation in our sample for firms whose IT sophistication index level does not change. Finally, ε_{it} is an error term.

As an alternative identification approach, we exploit the changes in firms' C-Index variable to analyze the reactiveness of firms with a digital infrastructure to altered income shifting incentives. We expect that a higher degree of IT sophistication enables firms to better adjust their reported income towards new income shifting incentives, i.e., to appropriately change decisions in response to an altered situation.

4. Results

4.1. Descriptive results and graphical evidence

Before providing the results of our regression approach, we analyze our sample descriptively, focusing on our IT sophistication index. Table 4 depicts the descriptive statistics of our sample. The average firm has total assets of more than 123 million euro and profits before tax of more than 8.6 million euro during the sample period. On average, firms do not have an incentive to shift profits in either direction (C-Index of -0.001). The median firm has access to two software categories. As outlined in Table 3, the IT index is zero for less than 20 percent of our sample and in more than 25 percent of the firm-years, the index has the highest value of three.

Furthermore, we descriptively plot firms' profits measured as return on assets against firms' income shifting incentives to relocate income. We use return on assets rather than absolute PLBT values to increase the descriptive comparability of firms. Figure 1 depicts the binned scatter plot following Giroud and Mueller (2019). The binned scatter plot clusters firms along the range of possible C-Indices into 15 groups and plots the average return on assets per group. It is immediately visible that if firms have no incentive to relocate income – i.e., affiliates have a C-Index close to zero – the level of software sophistication is irrelevant for firms' average return on assets. However, if firms have a high incentive to relocate income outwards (positive C-Index), firms with high software sophistication, indicated by the green and yellow dots, have a low average return on assets, comparatively. On the other hand, firms in low-tax jurisdictions, with negative C-Index values, have a comparatively high profitability ratio if they have access to sophisticated software. The scatter plot indicates a negative association between the income shifting incentive and firm profitability only for digitalized corporations. The profitability of multinationals without sophisticated software seems relatively insensitive to the income shifting incentive measure.

4.2. Baseline Results

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 C-Index in Column 1 of Table 5, 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 four in Table 5 provide the baseline results for our first hypothesis. The coefficient of interest is the interaction of our income shifting incentive measure, C-Index, and the IT sophistication index. We estimate an interaction coefficient of -0.240. The statistically significant coefficient implies that firms with more sophisticated IT infrastructure exhibit a stronger tax responsiveness of reported profits than firms without this infrastructure. Figure 2 provides graphical evidence on the estimated profitability at different levels of IT sophistications 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 any 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.

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 5 Column 3. 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.

Finally, we replace the IT sophistication measure with a dummy variable that indicates if a firm has access to any software category. Column 4 shows that firms with an IT sophistication level of more than one shift significantly more income. The estimate 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 by more than 500 million euro (from 8.528 million to 9.087 million euro).

Interpreting differences in the C-Index can be difficult because many factors can influence the C-Index (De Simone et al. 2017). Anything else equal, a tax rate reduction of more than ten percentage points – as in the United States after the 2017 Tax Cut and Jobs Act or in Germany after the 2008 tax reform – has a considerable effect on the tax variable and reduces the incentive to relocate income towards low tax jurisdictions. We exploit the quasi-random changes in firms' C-Index variable to analyze the reactiveness of firms with a digital infrastructure to altered income shifting incentives and test our second hypothesis. Our setting of European affiliates is ideal for this approach as many European member states changed their statutory tax rates during our sample period. Thus, the relative tax attractiveness of affiliates is subject to several exogenous shocks. We focus in our analysis on affiliates that experience the largest downward and upward income shifting incentive shock.

The income shifting incentive shock is measured as the annual change of the affiliate specific C-Index. Firms in the lowest decile of this measure experience a large downward change of the C-Index. Thus, the affiliate's group has an incentive to shift income to the affiliate and we expect those with more IT sophistication to obtain more income. In contrast, firms in the highest decile experience a large upward change of the C-Index. Therefore, the affiliate's group has an incentive to lower the reported income of the affiliate. We expect that firms with high IT sophistication can react to this change in income shifting incentives more efficiently. Our results are depicted in Table 6. The first column analyzes the firms in the lowest shock decile, i.e., firms with a negative C-Index change. We interact the dummy that identifies firm-years with the largest negative C-Index changes with our IT sophistication dummy. The coefficient estimate implies that digital firms react more to the income shifting incentive change with an upward adjustment of their reported income. Column two analyzes the group of firms with the largest positive C-Index changes. We find a significant negative interaction coefficient, which is in line with our expectations. This provides evidence that the tax department of digital corporations can incorporate altered circumstances better than the one of non-digital firms.

Our results provide evidence on the association between IT sophistication and decision making for 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.

4.3. 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 IT sophistication 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 7 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 better knowledge 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 3 and 4 of Table 7 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.

4.4. 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 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.

Second, in Table 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 Table 9 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-Index, 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. The C-Index, which is a weighted tax rate differential, can be affected by many different factors (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 estimation in column 3 and 4 of Table 9 indicates 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 5 and 6 of Table 9 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.

5. Conclusion

Our paper investigates whether highly digitalized firms make use of the abundance of data provided by the digital infrastructure to improve the performance of their tax function in the sense that they take more effective tax planning decisions. We see this as an exemplary study shedding light on how digital sourcing of intra-firm data affects decision making in integral parts of business functions. 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 expect that the use of sophisticated IT 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 apply the well-known Huizinga and Leaven (2008) income shifting model to evaluate if reported profits of multinationals with sophisticated IT are more sensitive to an income shifting incentive measure.

We first develop a novel dataset that combines survey data on IT usage in European affiliates over the period 2005 to 2016 with rich financial data from the BvD ORBIS database. Our IT sophistication index captures firms' access to up to three key software solutions – that capture three relevant dimensions of digitalization – to digitally monitor and manage firm performance: ERP software, DBMS and groupware software.

Next, we provide descriptive evidence that if firms have a high (low) incentive to relocate income outwards (C-Index positive (negative)), firms with high software sophistication have a relatively lower (higher) average return on assets. This initial evidence is consistent with our empirical analysis. We estimate an interaction coefficient of -0.240. The statistically significant coefficient implies that firms with more sophisticated IT infrastructure exhibit a stronger tax responsiveness of reported profits than firms without this infrastructure. Following an alternative identification strategy, we exploit the changes in the C-Index variable to show that firms with a higher IT sophistication index react more strongly to quasi-random shocks in tax planning incentives. 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 evidence on the association between IT sophistication 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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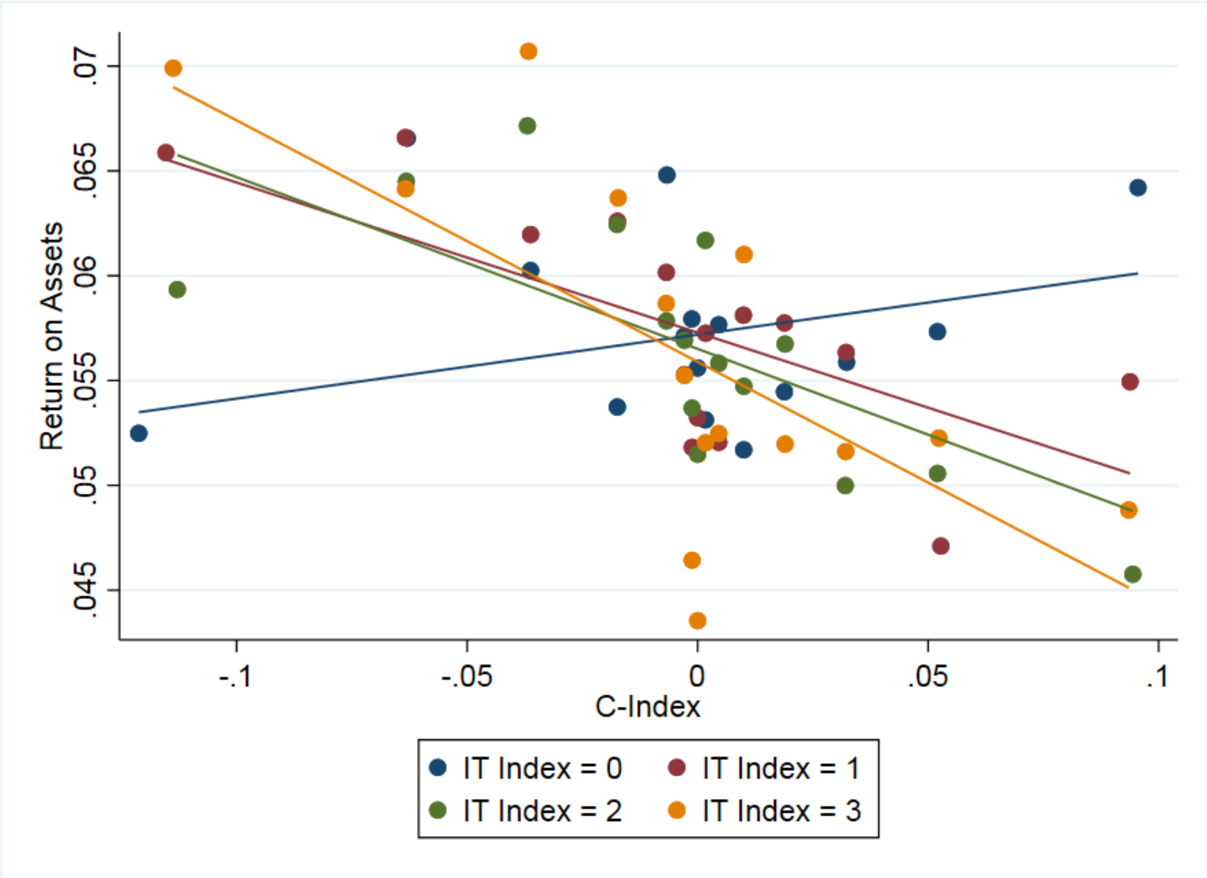
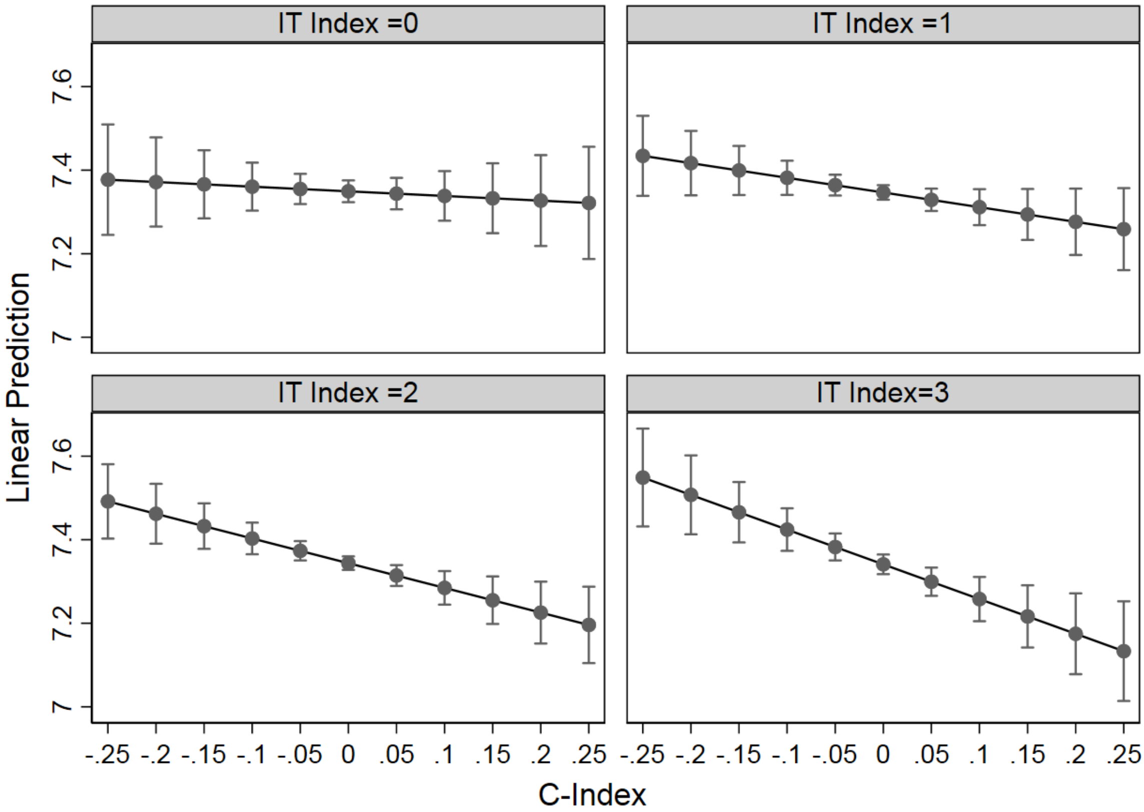
FIGURES

Figure 1: 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-Index. The colored dots depict the average return on assets (in decimals) within each bin at the bin's average C-Index value (in decimals). Each color represents a different degree of digitalization. The plotted lines provide an estimate of the linear relation between the C-Index and the return on assets. It controls for firm- and industry-fixed effects.

Figure 2: Tax sensitivity at different IT index levels



Notes: The Figure depicts the predictive margins of the logarithm of PLBT over the C-Index range for different levels of the IT Index. The vertical lines represent the 95% confidence interval.

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-Index	-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

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	100	0.07%	13	0.05%
United Kingdom	17,264	11.92%	3,236	13.09%
Total	144,795		24,715	

Notes: The table depicts the country dispersion.

Table 3: Index composition

IT Index level	firm-years	in percent
0	28,455	19.65%
1	28,290	19.54%
2	51,093	35.29%
3	36,957	25.52%
Total	144,795	

Table 4: Descriptive Statistics

Variable	**n**	**Mean**	**SD**	**Min**	**p25**	**Median**	**p75**	**Max**
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 Assets	144,795	17,239	138,141	0	533	2,469	8,689	10,899,548
Employee Compensation	144,795	12,955	265,206	0	2,713	5,500	11,481	96,241,793
Ln(EBIT)	138,823	7.416	1.600	-3.244	6.426	7.435	8.432	15.902
Ln(PLBT)	144,795	7.350	1.764	-6.908	6.292	7.406	8.469	16.035
Ln(Tangible Assets)	144,795	7.608	2.165	-6.908	6.279	7.812	9.070	16.204
Ln(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-Index	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-Index and the CIT are stated in decimals.

Table 5: Baseline results

Dependent Variable: Log(PLBT)
Panel 2005-2016

	Baseline	Continuous interaction	Categorical interaction	Dummy interaction
Variable	(1)	(2)	(3)	(4)
C-Index	-0.516***	-0.111	0.153	0.154
	(0.177)	(0.267)	(0.298)	(0.298)
IT Index		-0.003		
		(0.007)		
IT Index = 1			-0.002	
			(0.018)	
IT Index = 2			0.004	
			(0.018)	
IT Index = 3			-0.010	
			(0.020)	
IT available				-0.002
				(0.017)
C-Index x IT 3 Index		-0.240**		
		(0.119)		
C-Index x IT Index = 1			-0.976***	
			(0.343)	
C-Index x IT Index = 2			-0.564*	
			(0.323)	
C-Index x IT Index = 3			-1.023***	
			(0.364)	
C-Index x IT available				-0.809***
				(0.290)
Log(Tangible Assets)	0.156***	0.156***	0.156***	0.156***
	(0.006)	(0.006)	(0.006)	(0.006)
Log(Employee Compensation)	0.686***	0.686***	0.686***	0.686***
	(0.011)	(0.011)	(0.011)	(0.011)
Productivity	4.468***	4.455***	4.448***	4.450***
	(0.346)	(0.346)	(0.346)	(0.346)
Log(GDP per Capita)	0.089***	0.090***	0.089***	0.090***
	(0.027)	(0.027)	(0.027)	(0.027)
Log(GDP)	0.007	0.007	0.007	0.006
	(0.008)	(0.009)	(0.009)	(0.008)
Unemployment	-0.006***	-0.006***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Year Fixed Effects	x	x	x	x
Industry Fixed Effects	x	x	x	x
Observations	144,796	144,796	144,796	144,796
Number of firms	24,715	24,715	24,715	24,715
R2 (within)	0.349	0.349	0.349	0.349

Notes: This table presents the regression results for the Huizinga and Leaven (2008) income-shifting model for 144,769 firm-years of European affiliates of multinational corporations. 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 6: Reactiveness of digitalized firms on income shifting incentive shock

Dependent Variable: Log(PLBT)
Panel 2005-2016

	Firm is in the lowest decile of C-Index changes	Firm is in the highest decile of C-Index changes
Variable	(1)	(2)
Decile Dummy	0.01	0.15***
	(0.03)	(0.03)
IT Index	-0.01	0.01
	(0.02)	(0.02)
Decile Dummy x IT Index	0.09***	-0.07**
	(0.03)	(0.03)
Log(Tangible Assets)	0.16***	0.16***
	(0.01)	(0.01)
Log(Employee Compensation)	0.69***	0.69***
	(0.01)	(0.01)
Productivity	4.64***	4.74***
	(0.35)	(0.35)
Log(GDP per Capita)	0.08***	0.08***
	(0.03)	(0.03)
Log(GDP)	0.00	0.00
	(0.01)	(0.01)
Unemployment	-0.01***	-0.01***
	(0.00)	(0.00)
Year Fixed Effects	x	x
Industry Fixed Effects	x	x
Observations	138,345	138,345
Number of firms	24,125	24,125
R2 (within)	0.350	0.350

Notes: This table presents the results for the changes in firm profitability in response to income shifting incentive shocks for all 138,345 firm-years of European affiliates of multinational corporations that experience a C-Index shock. The first two columns include a dummy that takes the value of one if the affiliate experiences a negative C-Index shock that is in the lowest decile of C-Index changes and zero otherwise (Decile Dummy). Comparably, columns three and four include a dummy equal to one if the firm experiences a positive C-Index shock in the highest decile of C-Index changes and zero otherwise (Decile Dummy). Columns two and four include an interaction of the Decile Dummy with a dummy that indicates if a firm has access to a specific software category that comprises our novel measure for the digitalization of firms (IT Index). 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: Cross-sectional analysis

Dependent Variable: Log(PLBT)
Panel 2005-2016

	Country dispersion		Accounting department	
Variable	(1)	(2)	(3)	(4)
C-Index	-0.105	-0.118	-0.139	-0.109
	(0.258)	(0.267)	(0.239)	(0.269)
Characteristic	-0.609***		0.048***	
	(0.031)		(0.017)	
C-Index x Characteristic	-0.666		-0.743**	
	(0.774)		(0.323)	
IT Index		-0.002		-0.001
		(0.007)		(0.007)
C-Index x IT Index		-0.073		-0.108
		(0.146)		(0.140)
C-Index x IT Index x Characteristic		-0.750**		-0.275*
		(0.381)		(0.152)
Log(Tangible Assets)	0.161***	0.156***	0.156***	0.156***
	(0.006)	(0.006)	(0.006)	(0.006)
Log(Employee Compensation)	0.663***	0.686***	0.686***	0.687***
	(0.011)	(0.011)	(0.012)	(0.012)
Productivity	4.484***	4.473***	4.383***	4.440***
	(0.344)	(0.346)	(0.350)	(0.349)
Log(GDP per Capita)	0.074***	0.088***	0.085***	0.088***
	(0.027)	(0.027)	(0.027)	(0.027)
Log(GDP)	-0.007	0.007	-0.002	0.004
	(0.008)	(0.009)	(0.009)	(0.009)
Unemployment	-0.005**	-0.006***	-0.007***	-0.006***
	(0.002)	(0.002)	(0.002)	(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 8: Robustness I – Non-interpolated IT index

Dependent Variable: Log(PLBT)
Panel 2005-2016

Variable	(1)	(2)	(3)
C-Index	-0.276	0.024	0.026
	(0.259)	(0.295)	(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-Index x SW 3 Index	-0.194*		
	(0.116)		
C-Index x IT Index = 1		-1.132***	
		(0.389)	
C-Index x IT Index = 2		-0.528	
		(0.322)	
C-Index x IT Index = 3		-0.889**	
		(0.359)	
C-Index x IT available			-0.775***
			(0.294)
Log(Tangible Assets)	0.156***	0.156***	0.156***
	(0.006)	(0.006)	(0.006)
Log(Employee Compensation)	0.684***	0.684***	0.684***
	(0.012)	(0.012)	(0.012)
Productivity	4.565***	4.556***	4.557***
	(0.349)	(0.349)	(0.349)
Log(GDP per Capita)	0.099***	0.098***	0.099***
	(0.027)	(0.027)	(0.027)
Log(GDP)	0.003	0.003	0.003
	(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)	0.350	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 9: Robustness II – Alternative control and dependent variables

Panel 2005-2016

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

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