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Technological Change and Countries' Tax Policy Design

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Abstract

We investigate whether technological change predicts tax policy changes in 34 OECD countries from 1996 to 2016. To examine tax policy reactions, we construct two new country-level indexes, one capturing tax-related investment incentives and one capturing anti-tax avoidance rules in a country. We document a decreasing trend in statutory tax rates, stable capital investment incentives, and a trend toward stricter anti-tax avoidance rules across countries over the last two decades. Our main finding is that country-specific exposure to technological change predicts variation in these trends. We find that, following technological changes, countries tighten their anti-tax avoidance rules. Cross-sectional tests show that smaller countries deviate from this general trend and use less stringent anti-tax avoidance rules. In the competition for firms' mobile capital, smaller countries thus appear to create indirect investment incentives by opting for less salient tax policy tools (i.e., anti-tax avoidance rules).

Keywords: Tax policy, technological changes, tax avoidance

JEL Classification: M48; H25; H26

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1 Introduction

An impetus for rethinking international corporate taxation stems from the rise of highly profitable, technology-driven, digital-heavy business models.

– Christine Lagarde, Chairman of the International Monetary Fund, Opening Remarks on Corporate Taxation in the Global Economy, Washington, D.C., March 25, 2019

In this study, we examine the role of technological changes in shaping countries' corporate tax policy design. With technology changing business models, countries face the challenge of updating their fiscal policies to fit new economic circumstances. Corporate tax policy is a key component of a country's fiscal policy because it has important consequences, not only for investment (House and Shapiro, 2008; Djankov, Ganser, McLiesh, Ramalho, and Shleifer, 2010; Zwick and Mahon, 2017; Giroud and Rauh, 2019), tax avoidance and profit shifting (Atwood, Drake, Myers, and Myers, 2012; Chen, De Simone, Hanlon, and Lester, 2017), risk-taking (Ljungqvist, Zhang, and Zuo, 2017; Bethmann, Jacob, and Müller, 2018), and thus economic growth (Romer and Romer, 2010; Barro and Redlick, 2011; Mertens and Ravn, 2013), but also for corporate tax revenues (Auerbach and Poterba, 1987; Goncharov and Jacob, 2014).

So far, little is known about what shapes countries' tax policies and the specific role technological changes assume therein. One challenge in analyzing corporate tax policy design is the issue of simultaneity (e.g., Devereux, Lockwood, and Redoano, 2008). Since countries compete with each other, one country reacts to tax rule changes in another country, and vice versa. Thus, it is difficult to isolate the causes of tax rule changes. To overcome this issue, one requires country-specific variation in the incentive to adjust tax policies. We propose that country-specific exposure to technological change can induce such variation in incentives. Another challenge is that tax policies are multifaceted and encompass not only statutory tax rates but also, for instance, rules that strive to incentivize investments (e.g., bonus depreciation schemes) and rules that aim to combat corporate tax avoidance (e.g., thin-capitalization rules). Despite a large literature on tax competition via statutory corporate tax rates (e.g., Kanbur and Keen, 1993; Slemrod, 2004; Devereux et al., 2008), little is known about what shapes corporate tax policies aimed at incentivizing investments or at curbing tax avoidance. We specifically account for such rules.

We contribute to the literature by examining whether country-specific exposure to technological changes precedes changes in Organisation for Economic Co-operation and Development (OECD) countries' tax policies. Specifically, we look at statutory tax rates, rules to incentivize investments, and rules to curb tax avoidance. Since countries differ in their industry composition, there is substantial cross-sectional variation in their exposure to technological changes. Such changes pressure policymakers to adjust corporate tax policy. For example, technological changes affect the mobility of capital and/or the ability to avoid taxes by shifting assets to low-tax countries. Technological change can thus lead to a mismatch between current tax policies and new economic realities (Desai and Hines, 2004). We propose that policymakers react to this mismatch by adjusting corporate tax policy. However, it is ex ante unclear which specific tax rules will be adjusted and how. We address this open empirical question in this study.

To study such tax policy adjustments, we require a proxy for country-specific exposure to technological changes. Our proxy exploits the idea that large technological changes affect the job composition of an industry (David and Dorn, 2013). Since detailed occupation data are not accessible for many countries, we construct a measure for countries' exposure to U.S. industry job composition changes. Specifically, we first use U.S. census data to measure the proportion of information and communication technology (ICT) jobs in every U.S. industry. We then define large technology-driven changes as annual increases in the proportion of ICT jobs above the top quintile of the distribution of changes in ICT jobs. Next, we construct measures of an industry's importance for a given country using OECD value-added data. Finally, we construct annual country-specific measures of exposure to U.S. technological changes by weighting and aggregating the occurrence of U.S. industry technological changes with the importance of each industry for a country.

Our measurement approach offers several benefits and addresses the issue of simultaneity. First, using U.S. census data provides a long time series of industry-specific technological changes. Since tax policy is sticky over time, a longer time series is crucial for empirical analysis. Second, measuring technological changes at the industry level allows us to exploit country differences in industry composition, enabling us to track cross-country variation in technological change. Third, the use of technological change measures from all OECD countries would result in a potential endogeneity concern that is mitigated by the use of exposure to U.S. technological changes.[1] We provide empirical evidence that other countries' corporate tax

[1] Alternatively, one could consider international patent applications data to develop a proxy for technological change. However, a patent-based approach has substantial limitations and measurement issues for our purpose, which requires a country-level measure of technological change. First, although the location of the patent owner or patent applicant can be defined relatively precisely, the location of the technological change is hard to measure because one needs the location of the ultimate user of breakthrough patents. Second, patents can be used across industries, making it hard to allocate large changes in one industry according to the importance of the industry across countries. Given these limitations, we opt for our measure using ICT jobs.

policies do not predict U.S. technological changes. Further, given the role of the United States in the global economy, U.S. technological changes are likely representative of global technological changes.[2]

To operationalize countries' tax policy choices, we construct measures for three different corporate tax policy dimensions in 34 OECD countries over the 1996–2016 period.[3] First, we follow prior literature and collect data on statutory tax rates (Slemrod, 2004; Devereux et al., 2008; Vegh and Vuletin, 2015). Second, we collect data on nine tax base elements (e.g., loss offset rules and bonus depreciation) to construct an index capturing tax-related investment incentives. Third, we construct an index consisting of nine items capturing tax rules intended to combat tax avoidance (anti-tax avoidance rules). Among others, these nine items comprise thin-capitalization rules and transfer pricing regimes designed to reduce cross-border profit shifting (e.g., Buettner, Overesch, Schreiber, and Wamser, 2012; Dharmapala, 2014).

Our empirical analysis proceeds in four steps. First, we present descriptive evidence on our three tax policy measures. Although we observe a trend toward stricter anti-tax avoidance rules and a decline in our sample countries' statutory tax rates over time, we do not find a clear trend concerning traditional investment incentives. Irrespective of the observed trends, our results do not suggest that tax policies are converging across countries. In fact, the variation across countries in each of the three tax policy dimensions remains high or even increases slightly over time.

Second, we employ a lead-lag design following Reinhart and Rogoff (2011) and Hail, Tahoun, and Wang (2018). We find that technological change exposure incrementally predicts stricter anti-tax avoidance rules. No statistically significant relation can be observed between technological changes and changes in the other two tax policy dimensions (i.e., in statutory tax rates and traditional investment incentives). We interpret this evidence as consistent with the notion that technological changes raise firms' opportunities to shift income into low-tax countries via intangibles or labor relocation decisions (e.g., Drake, Goldman, and Murphy, 2018). Our findings suggest that countries react to such shifting activities by setting stricter anti-tax avoidance rules. Traditional investment incentive rules, such as accelerated depreciation schemes for tangible assets, do not respond to technological changes. Our results are robust to a battery of robustness tests (e.g., using other cutoffs for our technological change definition, allowing for country-specific trends,

2 Prior research often assumes that the United States is one of the largest consumers of technological innovation (Acharya and Subramanian, 2009; Hsu, Tian, and Xu, 2014). This stems from the observation that most meaningful innovations outside the United States are also covered by the U.S. Patent and Trademark Office (He, Jacob, Vashishtha, and Venkatachalam, 2019). We thus expect U.S. technological changes to be representative of global technological changes.

3 From the current list of 36 OECD countries we exclude the United States (due to potential endogeneity issues with our technological change measure) and Estonia (due to a corporate tax rate of 0%, if profits are retained).

controlling for other countries' tax policies, or using a change specification). Our baseline findings thus provide evidence supporting the argument of Desai and Hines (2004) that spurring corporate investment via traditional investment channels has "frustrated" policymakers in the recent past. Instead, we show that countries appear to rely on anti-tax avoidance rules.

Third, we examine cross-sectional differences in countries' response to U.S. technological changes. The literature on tax competition argues that contextual factors can lead to cross-sectional variation in countries' tax policy design (Bucovetsky, 1991; Wilson, 1991). In this case, the average reaction to technological changes could conceal important competitive dynamics between countries. Baldwin and Krugman (2004) argue that, because of their size, large countries are able to retain capital despite high tax rates or strict anti-tax avoidance rules (the agglomeration rent argument). In additional tests, we account for cross-sectional variation in country size. Our findings indicate that smaller countries deviate from the general trend toward stricter anti-tax avoidance rules and react significantly less to technological changes than larger countries. We do not find significant incremental associations between lagged technological changes and the other two tax policy variables. Our findings are consistent with smaller countries exploiting less salient, indirect investment incentives in the global competition for capital. By setting less strict anti-tax avoidance rules, small countries provide firms greater flexibility and more opportunities to reduce tax payments and, ultimately, to incentivize investment.

In the final step, we present two arguments that could rationalize why the response of smaller countries to technological changes differs from that of larger countries. First, we try to provide a rationale for the difference between smaller and larger countries by examining how our tax policy measures relate to three firm-level outcomes (i.e., investment, tax avoidance, and a firm's capital structure). Using data on listed firms from Compustat Global and Compustat North America, we find that anti-tax avoidance rules are negatively associated with investments but positively associated with effective tax rates (ETRs) for firms in our sample countries. Consistent with Baldwin and Krugman (2004), one plausible explanation for the tightening of anti-tax avoidance rules in large countries is that they can put more weight on reducing tax avoidance to secure corporate tax revenues. In contrast, smaller countries appear to put more weight on incentivizing investment relative to collecting corporate tax revenues, since they do not tighten anti-tax avoidance rules following technological changes. This empirical finding is consistent with the model by Hong and Smart (2010) on incentivizing investments via less stringent thin-cap rules.

The second argument that can plausibly explain why countries adjust anti-tax avoidance rules instead of reducing corporate tax rates relates to the salience of different tax policy tools. Tax rates are very salient and can be easily understood by the public and other countries. Because of this salience, tax rate cuts have a higher likelihood of triggering undesired tax justice debates (e.g., the minimum corporate tax rate debate in Europe).[4] Anti-tax avoidance rules, in contrast, are often complex and hard to communicate as a simple number (e.g., an ETR), and thus less salient to the public. To illustrate this point, we show that, around the Tax Cuts and Jobs Act of 2017 in the United States, the tax rate cut received considerably more media attention than the broad set of adjusted or newly introduced anti-tax avoidance rules. Provisions such as the global intangible low-tax income (GILTI) tax received very little attention, even from the business press.

Our study contributes to the literature in several ways. First, we contribute to the literature on the role of tax competition for tax policy design and the "race to the bottom" phenomenon (Kanbur and Keen, 1993; Kind, Knarvik, and Schjelderup, 2000; Devereux et al., 2008; Hong and Smart, 2010; Devereux, 2012). Our results indicate that recent trends in technological development have changed the way in which countries compete. Prior literature suggests that countries compete via statutory tax rates (Slemrod, 2004; Devereux et al., 2008). However, at least in response to technological changes, our results suggest that smaller countries set less strict anti-tax avoidance rules, to create indirect investment incentives, while larger countries use stricter anti-tax avoidance rules to preserve tax revenues. Hence, despite multilateral harmonization efforts—such as the OECD Base Erosion and Profit Shifting (BEPS) project—countries seem to set tax policies in a way that best caters to national interests (as indicated by our findings on anti-tax avoidance rules).[5] We thus add to Devereux and Vella (2014), who propose that international harmonization efforts, such as the OECD BEPS Project, will not curb existing tax competition across countries.

Second, we contribute to the literature on the determinants and consequences of tax policy. For example, Goncharov and Jacob (2014) examine the tax revenue consequences of accrual versus cash tax accounting. Another large stream of the literature examines the effects of corporate taxes on investment responses (Djankov et al., 2010; Giroud and Rauh, 2019), risk taking (Ljungqvist et al., 2017; Langenmayr and Lester,

[4] Jointly with France, the German Minister of Finance has suggested a minimum corporate tax rate to combat tax avoidance. See, for example, https://www.handelsblatt.com/today/finance/google-tax-alternative-scholz-wants-minimum-corporate-tax-rate-in-oecd/23583674.html, accessed September 16, 2019.

[5] For example, the then chair of the U.S. Senate Committee on Finance, Orrin G. Hatch, and the then chair of the House Committee on Ways and Means wrote in their joint statement on BEPS that "Congress is tasked with writing the tax laws of the United States, including those associated with cross-border activities of U.S. Companies. Regardless of what the Treasury Department agrees to as part of the BEPS Project, Congress will craft the tax rules that it believes work best for U.S. companies and the U.S. economy" (https://www.finance.senate.gov/chairmans-news/hatch-ryan-call-on-treasury-to-engage-congress-on-oecd-international-tax-project, accessed November, 29, 2018.

2018), or capital structure (Heider and Ljungqvist, 2015). We show that U.S. technological changes relate to future tax policy changes in other OECD countries. This is consistent with countries adjusting their corporate tax policy to combat tax avoidance opportunities induced by technological change. In addition, our study points toward the potential endogeneity of corporate tax policies. We thus complement prior research on the endogeneity and exogeneity of tax policy design (e.g., Romer and Romer, 2010) by showing that corporate tax policy is partly endogenous to technological changes. Our paper also adds to prior literature on the determinants of countries' implementation of accounting regulation (e.g., Nobes, 1991; Waymire and Basu, 2011; Hail et al., 2018).

Finally, we believe that the resources we develop in our study—the cross-country technological change data, as well as the tax policy measures—can be valuable for future empirical research on the real effects of taxation or on the consequences of technological changes. Our tax policy variables provide a comprehensive overview of different tax policy tools (tax rates, investment incentives, and anti-tax avoidance rules) in OECD countries over the past two decades.

We acknowledge that our study faces several limitations. Our proxy for technological changes can only measure technological change on a coarse level. It thus suffers from measurement error. While we do not have a reason to suspect that this measurement error is correlated with a foreign country's tax policy, a more precise proxy of technological changes would provide more power for statistical tests. Similar, our tax policy indexes are summary measures with some arguably arbitrary choices, such as similarly weighting each item. Another potential limitation is that we can only examine the rules set by policymakers, but not the level of enforcement. However, our objective is to examine the determinants of corporate tax policy choices. An interesting and important avenue for future research is to analyze the effectiveness and macroeconomic consequences of setting corporate tax policy along the three dimensions of tax rates, investment incentives, and anti-tax avoidance rules.

2 Hypothesis Development

To derive our hypotheses, we first consider policymakers' rationale for tax policy design choices. When setting corporate tax policies, countries must balance multiple potentially conflicting objectives, such as attracting foreign investment (to generate additional tax revenues), combating tax avoidance (to obtain an equitable tax system where every firm pays its "fair" share), or securing predictable tax revenues that are ideally less procyclical. The trade-off policymakers face when setting their tax policies is further complicated by international aspects. Countries compete for capital and other production factors, such as labor (e.g., Kind et al., 2000). While some countries can exploit the signaling effect of low statutory tax rates to attract investments, others can set investment incentives via tax base elements (e.g., immediate write-off rules for selected assets). In addition, one country's tax policy can have important implications for the tax policy design of other countries. Hence, countries' tax policy design choices should not be considered in isolation but, rather, conditional on other countries' tax policies (Wilson, 1986, 1987, 1999; Zodrow and Mieszkowski, 1986; Black and Hoyt, 1989; Bucovetsky and Wilson, 1991; Janeba, 2000; Wilson and Wildasin, 2004).

Despite the large amount of theoretical work, the dynamics arising from tax competition pose significant challenges for an empirical analysis, since one country's tax policy can depend on the tax policy design choices of other countries, and vice versa. One thus needs shocks to the equilibrium to examine how countries respond and how the responses differ across countries. We propose that technological changes represent shocks to a country's tax policy design. Technological changes can not only change corporate input factors but also affect firm operations, opening up new avenues to develop, produce, and sell products, which can also create new opportunities for tax avoidance. Thus, after large technological changes, corporate tax policy needs to keep pace with new economic realities.

In line with this reasoning, the OECD (2015), in its 2015 BEPS Action Plan, points out that the rise of the digital economy is challenging existing tax systems, since digitization and technological change reduce distances and increase cross-border mobility. The OECD (2015) identifies the mobility of intangibles and business functions, the volatility of the changing business models (resulting from low entry barriers and rapidly evolving technologies), and the nexus of taxation as key tax challenges resulting from recent technological changes.

If technological changes create tax policy mismatches (i.e., existing tax policies no longer fit economic realities), countries can feel the pressure to react to secure corporate tax revenues (Desai and Hines, 2004).[6] To do so, policymakers can use various tax policy tools. We divide tax policy tools into three groups. First, countries can adjust statutory tax rates. The statutory tax rate is the most salient tax policy tool (see also Section 4.4.2) and the predominant characteristic considered in policy comparisons (e.g., European Commission 2015; OECD 2018) and corporate decision making (e.g., Buettner and Ruf, 2007; Graham,

6 The United States, for instance, was highly criticized prior to the 2017 U.S. tax reform for not having kept pace with immense economic changes in the United States and on a global level (Auerbach and Smetters, 2017).

Hanlon, Shevlin, and Shroff, 2017; Powers, Seidman, and Stomberg, 2017). Second, countries can set investment incentives via tax base elements such as depreciation schedules, provisioning, or loss offset rules.[7] Third, countries can introduce anti-tax avoidance rules aimed at preventing corporate attempts to reduce tax payments by exploiting legal arrangements.

To the best of our knowledge, theoretical work has not developed unambiguous, testable predictions on how countries adjust the three tax policy tools in response to large technological changes. Such changes, which primarily increase the mobility of intangible assets, could potentially induce an increase in anti-tax avoidance rules, since countries strive to combat profit shifting. However, if competition for capital is severe enough, stricter anti-tax avoidance rules could have the undesired effect of triggering corporate relocation to more favorable jurisdictions. Alternatively, countries could react to technological changes by raising traditional investment incentives or by reducing statutory tax rates. At the same time, due to salience, tax rate cuts could trigger undesired public debates about tax justice. Moreover, tax rate cuts can have the undesired consequence of competing countries potentially following and also cutting rates, thereby potentially diminishing any competitive advantages (the race to the bottom argument). Picking less salient tax policy tools could thus represent a way to realize more persistent competitive advantages. In light of the above, we consider countries' tax policy reactions to technological changes as an open empirical question. We therefore formulate our hypotheses as follows.

H1 : *Technological changes trigger policy changes in statutory tax rates.*

H2 : *Technological changes trigger policy changes related to investment incentives.*

H3 : *Technological changes trigger policy changes in anti-tax avoidance rules.*

Moreover, there are several reasons why the responses could differ across countries, depending, in particular, on the size of the country. For example, Bucovetsky (1991) and Wilson (1991) argue that the after-tax cost of capital in large countries is less sensitive to tax rate changes relative to small countries. Large countries will thus compete less vigorously for capital, resulting in relatively higher tax rates in large countries than in small countries. Consistently, Baldwin and Krugman (2004) argue that industrial concentration and well-developed infrastructure can result in agglomeration rents. For instance, a car manufacturer will likely

[7] Combinations of these potential policy reactions can be observed. For instance, a popular strategy pursued by many countries is a tax rate cum base-broadening strategy, which implies that the tax base is broadened through tax policy measures while there is a simultaneous reduction of the statutory tax rate in a country (e.g., Devereux, 2012). An example of a tax reform that led to simultaneous adjustments of the statutory tax rate and tax base elements was the U.S. Tax Reform Act of 1986.

locate its business close to suppliers. The resulting economies of scale and network effects from corporate agglomeration allow large countries with high industrial concentration to charge higher tax rates or to tighten anti-tax avoidance rules without losing capital due to lock-in effects. Effectively, these lock-in effects make corporate capital less mobile. If the effect of technological changes on capital mobility varies with country size, the tax policy reaction to a technological change in a larger country might not necessarily represent the appropriate tax policy choice for a smaller country. Taken together, we expect that countries' tax policy responses to technological changes differ with respect to country size.

3 Data Collection and Research Design

3.1 Sample Construction

Our final sample comprises data from 34 OECD countries over the period 1996 to 2016. We focus on OECD countries for several reasons. First, data on industry weights, which are necessary to construct our measure of countries' exposure to technological changes, is only available for OECD countries. Moreover, we can collect detailed data on tax policy characteristics for these countries. Second, the extent of economic integration of most OECD countries allows us to focus on tax policy changes at the country level while accounting for competitive pressures and policy externalities among countries. Taking all OECD countries as a starting point, we drop Estonia from our sample because it does not levy any corporate income tax, as long as profits are retained.[8] We further exclude the United States from our analyses to overcome endogeneity concerns related to our core explanatory variable, which is based on U.S. technological changes.

3.2 Measure Construction and Variation

3.2.1 Tax Policy Measures

When setting their corporate tax policies, countries use different policy tools. Statutory tax rates, denoted *StatTR*, represent the most salient tool of a country's tax policy. We collect data on statutory corporate tax rates from the OECD Stats database and the Ernst & Young Corporate Tax Guides.[9] While, prior research focuses almost exclusively on statutory tax rates (Slemrod, 2004; Vegh and Vuletin, 2015), we argue that

8 Estonia solely levies taxes upon profit distribution (e.g., dividends, fringe benefits, or payments not related to the payer's business). Corporate income per se is not subject to taxation in Estonia.

9 We follow prior work (e.g., Devereux, Griffith, Klemm, Thum, and Ottaviani, 2002; Alexander, De Vito, and Jacob, 2019) and calculate the sum of the top marginal tax rates, the average local tax rates, and supplementary charges whenever regional differences in statutory tax rates exist for a country (e.g., for Germany and Italy).

statutory tax rates alone do not sufficiently capture the variety of corporate tax policy tools (Devereux and Griffith, 1998). To account for other tax policy tools, we construct two additional indexes: one captures tax policies that strive to stimulate investment in a country (*InvScore*) and the other comprises a country's set of anti-tax avoidance rules (*AntiTAScore*). Table 1 shows information on index construction.

We collect the necessary data for constructing the two indexes from the *European Tax Handbooks* published by the International Bureau of Fiscal Documentation (IBFD), the PricewaterhouseCoopers *Worldwide Summaries – Corporate Taxes*, the Ernst & Young *Corporate Tax Guides*, the OECD Stats database, and countries' official tax authority websites.[10] Generally, both indexes consist of nine items and theoretically range from zero to one. Higher values of *InvScore* indicate tax policies with more rules aimed at fostering corporate investment. Higher values of *AntiTAScore* indicate greater regulatory effort to combat corporate tax avoidance.

As listed in Table 1, our investment score measure, *InvScore*, comprises nine components. The first two components, the loss carryback rule and loss carryforward restrictiveness, follows the operationalization of Bethmann et al. (2018). The term *InvScore* further contains three binary items referring to tangible assets (i.e., accelerated depreciation, immediate write-offs, and bonus depreciation) and one item referring to intangible assets (i.e., research and development, or R&D, incentives). To equally weight tax incentives referring to tangible and intangible assets, we use adjusted weights for the three items related to tangible asset treatment. For the construction of R&D incentives, we follow the general methodology of the B-index (McFetridge and Warda, 1983; Warda, 2001). The B-index proxies for the fiscal generosity of tax systems with respect to R&D investments (see Bloom, Griffith, and van Reenen, 2002; Wilson, 2009). We adjust the original B-index by holding the statutory tax rate constant over time. We thereby ensure that changes in our adjusted B-index are not mechanically driven by statutory tax rate changes, which we consider a separate tax policy dimension. Consistent with the interpretation of the original B-index, lower values of our modified B-index represent higher R&D tax incentives. We subtract our modified measure from one and normalize the resulting measure over the range between zero and one. Finally, *InvScore* contains binary items accounting for (1) an allowance for a corporate equity system, (2) a group tax relief system, or (3) any tax rules granting beneficial tax treatment to venture capital investments. All these items represent reductions in the after-tax cost of capital investment. Hence, higher values indicate more favorable investment conditions.

[10] We cross-check country-year observations of specific index items with the data of Alexander et al. (2019) and Jacob, Michaely, and Müller (2019) as long as the same country-years and items are available.

Our second index, *AntiTAScore*, measures countries' corporate tax rules to combat corporate tax avoidance. The index also comprises nine items (see Table 1).[11] We include binary items for the existence of a general anti-avoidance rule, hybrid mismatch rules, an exit tax regime, a tax-related disclosure regime, and country-by-country reporting rules. Moreover, a categorical variable accounting for the progressiveness of the transfer pricing regime is included in *AntiTAScore*. To account for the strictness of controlled foreign corporation (CFC) regimes, we construct a measure that consists of the low-tax threshold set in a CFC regime, divided by the statutory tax rate in the country of control. Larger values of our CFC item thus represent stricter CFC regimes. We also account for the strictness of earnings-stripping and thin-capitalization rules in a country, building on the methodology of Buettner et al. (2012).

Figure 1 presents the average time trends for each tax policy measure. We observe declining tax rates, relatively stable investment incentives, and a trend toward stricter anti-tax avoidance rules over time. Figure 1 also reports the variation of these tax rules across countries. The gray areas depict interquartile ranges. The interquartile ranges reveal substantial variation in the general trend. For all three tax policy measures, we do not observe any convergence in tax policy design across countries. Instead, variation seems to increase over time, despite coordinated tax policy efforts at the European Union or OECD level to harmonize tax policies.

Figures 2 and 3 present the levels of our three tax policy measures (*StatTR*, *Inv-Score*, and *AntiTAScore*) for each sample country over the period 1996–2016. Figure 2 shows the country-level variation in statutory tax rates. Some countries maintain relatively high statutory tax rates over the full sample period (e.g., France, Germany, and Italy), whereas others historically rely on low statutory tax rates (e.g., Hungary, Ireland, and Latvia). One potential explanation for this divergence in statutory tax rates is that the first group of countries benefits from agglomeration rents and can maintain higher statutory tax rates without losing mobile capital. The latter group seems to consist of rather small (periphery) countries. These countries appear to use the salience of low statutory tax rates intentionally, to attract mobile capital and overcome other location disadvantages such as a less developed infrastructure (for similar argumentation, see, e.g., Garretsen and Peeters, 2007). Generally, we observe a declining trend in statutory tax rates toward a rate of approximately 25% during the last decade. Figure 2 also shows that countries with historical tax rates higher than the 25% level converge to this rate from above, whereas some countries with historically low tax rates (e.g., Chile and the Slovak Republic) approach the average level of 25% through slight increases in

[11] Most of these items are also specific actions in the OECD BEPS initiative.

their statutory tax rates over time. However, despite the declining trend, on average, there seems to be high cross-sectional variation in statutory tax rate levels. Figure 2 further suggests that some countries seem to frequently change their statutory tax rates over the sample period considered (e.g., Greece), whereas other countries exhibit rather constant statutory tax rate levels over time (e.g., Norway and Sweden). Moreover, the majority of (large) tax rate cuts seems to occur in the first half of our sample period. After 2006, statutory tax rates appear relatively stable.

Figure 3 plots our two indexes, *InvScore* and *AntiTAScore*, for our sample countries. Over the sample period, *AntiTAScore* appears to be more volatile than *InvScore*. Although the average level of investment incentives (*InvScore*) does not change substantially over time, several smaller OECD countries (e.g., Belgium, Ireland, Luxembourg, and Lithuania) seem to exhibit comparably high *InvScore* levels. The high *InvScore* levels can be explained by several tax reforms in these countries during the last years. Belgium, for instance, introduced an intellectual property (IP) box regime in 2007, intended to incentivize corporate investment through the provision of beneficial tax treatment for Belgian patent income.[12] The high *InvScore* levels for Ireland and Luxembourg, depicted in Figure 3, reflect the fact that both countries are often classified as European tax havens (Hines and Rice, 1994).[13] Ireland offers investment incentives not only through low statutory tax rates but also through tax base–related investment incentives. For instance, in 2004, Ireland introduced an R&D tax credit, granting a significant tax exemption to firms with R&D activity in the country. In 2009, the Irish government created further investment incentives through providing beneficial tax treatment to start-up firms investing in Ireland. In contrast, Switzerland, Korea, and the Netherlands exhibit comparatively low levels of our *InvScore* measure.[14] Countries with surprisingly high levels of *InvScore* are, for instance, the United Kingdom, France, Portugal, and Spain. The fact that the latter three countries have developed relatively similar levels of *InvScore* could stem from regional tax policy spillovers. Prior literature suggests that a country's tax policy design represents a reaction to other countries' tax policy decisions, to reduce the effect of negative externalities (Devereux, Lockwood, and Redoano, 2007; Heinemann,

[12] Chen et al. (2017) argue that policymakers' primary objective to set up such a regime is to retain a strong position in the competition for mobile capital. The authors investigate the link between IP box regimes and corporate income shifting in a European setting and find evidence consistent with a negative association between outbound income shifting and the existence of an IP box regime in a country. In line with the investment stimulus objective, Bornemann, Laplante, and Osswald (2018) provide evidence suggesting that the Belgian IP box regime is associated with an incremental increase in the corporate innovative activity of Belgian companies.

[13] Consistent with Desai, Foley, and Hines (2006), we define tax havens as low-tax countries offering substantial tax avoidance opportunities to foreign investors.

[14] Korea and the Netherlands are sometimes classified as countries with certain tax haven characteristics (e.g., Altshuler and Grubert, 2006). The Dutch setting, for instance, enables firms to benefit from substantial tax benefits with regard to dividend and capital gains taxation.

Overesch, and Rincke, 2010). Such spillovers could explain why neighboring countries can align their tax policies over time.

With regard to anti-tax avoidance rules (*AntiTAScore*), Figure 3 corroborates the upward trend across countries shown in Figure 1. Many countries seem to implement anti-tax avoidance rules more toward the end of the sample period. This observation could be attributable to the OECD BEPS initiative begun in 2012. Moreover, many countries have recently implemented detailed transfer pricing documentation requirements to counteract firms' primary profit-shifting strategies (Lohse and Riedel, 2013; Heckemeyer and Overesch, 2017). Further, while some countries have implemented a variety of anti-tax avoidance rules (e.g., Australia, Canada, Germany, and France), others exhibit rather low *AntiTAScore* levels (e.g., Switzerland, Korea, and Slovenia). In addition, the timing of the implementation of anti-avoidance rules seems to vary across our sample countries. Some countries, such as the Netherlands and France, implemented anti-tax avoidance rules early on, whereas other countries, such as Chile and Ireland, only recently enacted such rules. Australia and the United Kingdom can be regarded pioneers in implementing certain anti-tax avoidance practices, which is also reflect in their high *AntiTAScore* levels and their recent policy actions.[15] Taking together the insights from Figures 1 to 3, it appears as if changes in tax policies do not cluster around single years or single countries. Instead, tax policy changes seem to vary over time and across countries. In our empirical approach, we try to examine the role of technological change in shaping these corporate tax policy changes.

3.2.2 Measuring Technological Change

We argue that technological changes are a source of country-specific variation in tax policy design. Our proxy choice exploits the fact that large technological changes likely affect the job composition of an industry (David and Dorn, 2013). However, detailed occupation data are not accessible for many countries. Thus, we rely on U.S. census data to construct a measure for countries' exposure to U.S. industry job composition changes. The use of U.S. technological changes offers several benefits. First, the use of U.S. census data provides a long time series of industry-specific technological changes. Since tax rules are relatively sticky over time, a sufficiently long time series is crucial for empirical analysis. Second, measuring technological changes at the industry level allows us to exploit country differences in industry composition, thereby

[15] In 2015, the United Kingdom implemented a diverted profits tax that strives to tackle aggressive tax avoidance structures used by multinational corporations. In 2017, Australia introduced a diverted profits tax as well. Additionally, the United Kingdom and Australia recently passed regulations that require firms to publicly disclose tax strategy information (the U.K. Finance Bill 2016 and the Australian Taxation Office Tax Transparency Code).

enabling us to track cross-country variation in technological change. For example, if a given industry experiences a transition, a country with greater reliance on this industry will be more affected by the technological changes than other countries. Third, the use of technological change measures from all the OECD countries would result in a potential endogeneity concern. Using exposure to U.S. technological changes mitigates this issue. We provide empirical evidence that other countries' corporate tax policies do not predict U.S. technological changes. Furthermore, given the role of the United States in the global economy, U.S. technological changes are likely representative of global technological changes. Prior research often assumes that the United States is one of the largest consumers of technological innovation (Acharya and Subramanian, 2009; Hsu et al., 2014). This stems from the observation that most meaningful innovations outside the United States are also covered by the U.S. Patent and Trademark Office (He et al., 2019). Thus, we expect U.S. technological changes to be representative of global technological changes. Although such a measure clearly has limitations, we believe that alternative proxies, for example, based on patents would have more severe limitations (see also footnote 2).

The rationale behind our technological change measure is as follows. Labor represents a key input factor of a firm's production function (Cobb and Douglas, 1928). Technological changes affect firms' production functions because technological progress changes input requirements. For instance, technological progress raises the need for higher-skilled jobs (Laitner and Stolyarov, 2003; David and Dorn, 2013). Hence, we argue that industry-specific technological changes should be reflected by changes in the job composition of the affected industry.

We measure U.S. industry job compositions based on census data provided by the Integrated Public Use Microdata Series project of the University of Minnesota (IPUMS, Ruggles, Flood, Goeken, Grover, Meyer, Pacas, and Sobek, 2019). We collect information on occupation and the industry employed for each sampled individual in the U.S. census. We subsequently identify occupations labeled ICT jobs and calculate the proportion of ICT jobs per U.S. industry and year. The selected occupation labels are listed in Panel A of Table A.2. To extrapolate the proportions for each industry, we approximate the number of individuals in each occupation and industry, based on the census sample weights.

We focus on ICT job proportions because the 2015 OECD (p. 13) report on taxing the digital economy highlights the role of ICT in transforming the business landscape: "The digital economy is the result of a transformative process brought by information and communication technology, which has made technologies cheaper, more powerful, and widely standardized, improving business processes and bolstering innovation across all sectors of the economy." Based on the notion that industry-specific technological changes should be reflected by changes in the ICT job composition of the affected industry, we use large and persistent changes in the proportion of ICT jobs as an indication of technological changes. Specifically, for each U.S. industry, we define a large technological change based on the distribution of annual changes in the proportion of ICT jobs. In our baseline specification, we chose the top quintile of the distribution of ICT job changes.[16] We then construct a binary variable that equals one for years with a large technological change and zero otherwise for a given industry. Figure 4 displays the event series of large technological changes for the selected U.S. industries. We observe that some industries experience multiple large technological changes, whereas others do not experience any large, substantial technological changes.[17]

In a subsequent step, we measure the extent to which our sample countries are exposed to U.S. technological changes, based on the respective country's industry composition. For example, a strong technological change in the U.S. manufacturing industry should be especially relevant to countries that rely significantly on manufacturing (e.g., Germany and Japan). In accordance with this rationale, we construct yearly measures for each country's technological change exposure, denoted TC, by weighting the U.S. technological change dummy with the importance of the respective industry in that country. We construct the industry weights for each country-year based on value-added data by industry, year, and country from the OECD STANi4 database.

Panel B of Table A.2 shows the chosen level of industry disaggregation.[18] Figure 5 shows the variation of technological change exposure across the 34 countries included in the sample. Since we use U.S. job changes to identify technological change events, the timing of these events is the same for all countries. This induces a sizable common trend. However, there is substantial cross-sectional variation in the exposure to these large technological changes across our sample countries. For example, in 2012, a year with significant overall changes, Luxembourg experienced a very large technological change, whereas Lithuania experienced a very minor one (because of differences in the extent to which both are exposed to technological change in the financial industry).

[16] In Table A.3, we show that our results are robust to the use of a broader (top quartile) as well as a narrower (top decile) cutoff. Additionally, the results are robust to the use of weights based on the OECD input–output tables.

[17] Since we base our definition on the proportion of ICT jobs, industries with very large non-ICT proportions, such as wholesale and retail, might not show up as experiencing large technological changes despite undergoing changes. Hence, we could be understating the exposure to technological changes. To address this concern, we use alternative cutoffs in our robustness tests.

[18] In a few cases, some country-years are missing values for some industries in our industry classification. This occurs most often when an industry value is only available for a higher level of aggregation for an earlier time period. To overcome this issue, we impute these values based on the time trends and industry proportions of the next higher industry level.

3.3 Research Design

Our basic research design follows the approach of Reinhart and Rogoff (2011) and Hail et al. (2018). Consistent with these two studies, we model the time series of our three tax policy variables as functions of their own past values and the past values of large technological changes. Stated differently, we use lead-lag relations to estimate the relation between technological changes and our three tax policy variables in three separate regressions. The following equation outlines the main specification for our tests of H1 to H3:

$$TaxPolicy_{i,t} = \beta_1 TC_{i,[t-1\,to\,t-3]} + \beta_2 TaxPolicy_{i,[t-1\,to\,t-3]} + \boldsymbol{x_{i,t-1}\phi} + \alpha_i + u_{i,t} \quad (1)$$

where $TaxPolicy_{i,t}$ is one of our three tax policy variables (*AntiTAScore*, *InvScore*, and *StatTR*), and $TC_{i,[t-1\,to\,t-3]}$ is the lag of the three-period backward-looking moving average of our technological change proxy TC.[19] The coefficient β_1 can be interpreted as the predictive ability of technological changes for tax policy changes, and $TaxPolicy_{i,[t-1\,to\,t-3]}$ is the lag of the three-period backward-looking moving average of the same tax policy measure used as dependent variable. It is included in the regression to account for potential time dependence between the design of current and previous tax systems. Thus, β_2 captures the potential persistence of tax policy design choices.

The vector $\boldsymbol{x_{i,t-1}}$ consists of several controls for macroeconomic and political conditions, which we obtain from the OECD and the World Bank. We follow prior literature (e.g., Devereux et al., 2008) and include lagged values of government expenditures, measured as a percentage of the gross domestic product, hereafter GDP ($GovExppGDP$), GDP growth ($GDPGr$), or GDP per capita ($GDPpCap$); unemployment, measured as a percentage of the total labor force in a country ($Unemp$); capital inflows, measured as foreign direct investment (FDI) inflows minus FDI outflows ($CapitalIn$); and election years ($ElYear$). We collect election data from the ParlGov Initiative (Döring and Manow, 2018). Detailed variable descriptions can be found in Table A.1. In addition, we include country fixed effects (α_i) and a trend variable ($Year$). We cluster standard errors at the country level. As Hail et al. (2018) note, the inclusion of year fixed effects is very conservative, since they capture general trends, including those related to our variables of interest. Since most of the variation in TC stems from variation across years, we try to pick up general trends through

[19] We account for three lag periods because of sampling considerations. Since we have 34 countries and 21 years, each additional lag year would decrease our sample size by more than 4%. Choosing an event window of three years is consistent with prior literature investigating policy changes and their determinants (e.g., Hail et al., 2018).

the $Year$ variable instead of including year fixed effects (Reinhart and Rogoff, 2011). In further robustness tests, we allow for country-specific trends.

Our research design in equation (1) offers the advantage of reducing collinearity through the inclusion of a single lag of a three-period backward-looking moving average instead of the inclusion of multiple lags (Reinhart and Rogoff, 2011). Accounting for more than one lag is crucial, since it is ex ante unclear whether tax policy will react to large technological changes and, if so, when. Hence, our approach also captures long-term tax policy reactions to technological changes. Furthermore, by including lagged values of the dependent variable, the research design also controls for potentially confounding factors, as depicted in Figure 6. One could, for example, argue that tax policy changes in the United States could drive U.S. technological changes and, at the same time, affect the specifics of other countries' tax policies (i.e., due to policy spillovers). As shown in Figure 6, such a potential relation is captured in lagged tax policy tools and in technological change exposure in the lead-lag design of Reinhart and Rogoff (2011).[20] A similar rationale holds for potentially confounding effects related to a country's institutional and economic environment. Since such factors tend to be fairly constant over time, they should already be captured by our lagged control variable $TaxPolicy_{i,[t-1\,to\,t-3]}$, as well as by our technological change variable $TC_{i,[t-1\,to\,t-3]}$.

3.4 Descriptive Statistics

Table 2 presents descriptive statistics for our sample. Our sample consists of 578 country-year observations for 34 countries. We lose some observations because of missing data on control variables and because we require several lags of technological changes. Table 2 provides two important insights. First, most countries do not use the full spectrum of tax policy tools. This becomes apparent from the 95th percentile of *AntiTAScore* being 0.51 and that of *InvScore* being 0.65. Second, the average exposure to a technological change (TC) in our sample countries amounts to 7%. This magnitude seems plausible, given that we weight technological changes according to industry affiliation. As shown in Figure 4, most technological changes occur in industries such as the telecommunication industry, which have a moderate weight in most countries.

[20] A further aspect, strengthening our identification, is the absence of any major (corporate) tax reform in the United States over the considered time period (1996–2016). Hence, U.S. tax policy can be considered relatively constant over time, and its effect on other OECD countries' tax policy design should be sufficiently captured by our lagged control variable $TaxPolicy_{i,[t-1\,to\,t-3]}$.

4 Results

4.1 Main Specification Results

In Table 3, we report the results from estimating our main specification for the three different tax policy variables. The results suggest that large technological changes primarily precede changes in a country's anti-tax avoidance rules, as indicated by the positive and significant coefficient for $TC_{i,[t-1\,to\,t-3]}$ in Column (3). This finding suggests that 100% exposure to a large technological change in the three preceding periods is associated with an increase of 0.402 in *AntiTAScore*. We consider this magnitude to be economically significant, given that the average exposure to large technological changes of our sample countries amounts to 7% (see Table 2). Our finding implies that this average exposure to technological changes is associated with an average increase of 0.03 in *AntiTAScore*, or 11% of the sample's median *AntiTAScore*. In contrast, we do not find a significant relation between $TC_{i,[t-1\,to\,t-3]}$ and either statutory tax rates (*StatTR*) or our investment incentive measure (*InvScore*).

The predictive ability of technological changes for anti-tax avoidance rules and the lack of a predictive ability for statutory tax rates and investment incentives could be interpreted as follows: the ongoing rise of new technologies changes business models in a way that new economy firms benefit from more mobile capital. Technological changes raise opportunities for such firms to shift income into low-tax countries via intangibles or labor location decisions (Drake et al., 2018). As our findings suggest, countries react to these shifting activities by tightening their anti-tax avoidance rules. More traditional investment incentives included in the investment score appear to be less important and, hence, are not adjusted following technological changes (Desai and Hines, 2004). We try to further explain this finding below.

The regressions in Table 3 also include a common linear time trend variable ($Year$) and our set of control variables. The trend variables are significant for tax rates (supporting the downward trend) and for anti-tax avoidance rules (supporting the upward trend) but are insignificant for investment incentives. Considering the coefficients of our controls variables, we find statistically significant coefficients on GDP growth ($GDPGr$) in Column (2). The findings are consistent with the idea that the policy design of investment incentives reflects countries' systematic responses to variations in their economic situation. Stated differently, our findings support the notion of the cyclicality of these rules (Vegh and Vuletin, 2015). In good (bad) times, tax policy design will focus less (more) on the creation of investment incentives, as indicated by the negative and significant coefficient when *InvScore* is the dependent variable.

4.2 Cross-Sectional Variation in Tax Policy Responses

Increased capital mobility following recent technological changes can also fuel competition among countries to attract capital through tax incentives (Devereux et al., 2008). However, our main results in Table 3 indicate that traditional tax policies that strive to encourage investments (*InvScore*) do not react to technological changes. One possible reason could be that our *InvScore* measure overweights tangible investment incentives (e.g., accelerated depreciation schemes for property, plant, and equipment). Given that new economy firms likely focus on the income shifting of intangibles or labor (Drake et al., 2018; De Simone, Mills, and Stomberg, 2019), traditional investment incentives might no longer represent an adequate tool to attract the investments of these new economy firms.

Another potential way for countries to attract corporate capital is by refraining to tighten anti-tax avoidance rules relative to other countries' attempts. The greater flexibility and more opportunities to reduce corporate tax payments can serve as an indirect tax incentive for corporate investment in a country. If this is the case, we would expect to see cross-sectional variation around the general trend toward stricter anti-tax avoidance rules. Baldwin and Krugman (2004) argue that large countries, because of their size, are able to retain capital despite high tax rates or strict anti-tax avoidance rules (the so-called agglomeration rent argument). To test for such cross-sectional variation, we rerun our baseline regression separately for small and large countries. To do so, we sort countries based on their population size and denote countries with a population below (above) the bottom tercile (top tercile) as $Small$ ($Large$).

Figure 7 plots the mean values of our three tax policy measures for the different size groups. In terms of traditional investment incentives, the countries do not differ much. However, for anti-tax avoidance rules, there seems to be substantial variation in the sample means among size groups. Larger countries appear to have stricter anti-tax avoidance rules than smaller countries.

Table 4 provides regression results for all three dependent variables. While there are no differences in the (nonsignificant) ability of technological changes to predict statutory tax rates and investment incentives, the results in Columns (6) to (9) show size-specific differences in the responses of anti-tax avoidance rules. Large countries exhibit a positive and significant relation between technological changes and anti-tax avoidance rules, as evidenced by the positive coefficient on $TC_{i,[t-1\,to\,t-3]}$. More importantly, the coefficient on $TC_{i,[t-1\,to\,t-3]}$ is much smaller and only borderline significant for small countries. As we show in the next section, the TC coefficient of small countries is not robust in additional tests. Importantly, the difference between small and large countries in the anti-tax avoidance rule response to technological change is also statistically significant. This result suggests that small countries react to technological changes by deviating from other countries' trend toward stricter anti-tax avoidance rules. Large countries tighten anti-tax avoidance rules after large technological changes, but small countries do not follow this trend. This is consistent with the idea that smaller countries use less strict anti-tax avoidance rules to attract corporate investments. In contrast to small countries, large countries (e.g., due to agglomeration rents) can be less concerned about capital outflows but more concerned about tax revenues.

To gain a better understanding of the specific anti-tax avoidance rules used by countries to create such incentives, we disaggregate *AntiTAScore* and rerun the size split specification from Table 4 for each of the nine items.[21] Table 5 reports the results of these additional tests. We observe significantly positive changes in hybrid mismatch rules, thin capitalization rules, country-by-country reporting, and exit tax rules for large countries exposed to technological changes. While the negative coefficient on transfer pricing rules can look surprising at first, it is consistent with the positive coefficient observed for country-by-country reporting. Taken together, the two coefficients are consistent with country-by-country reporting substituting information provided by transfer pricing documentation (Joshi, 2019).

Smaller countries exhibit significantly weaker reactions and only follow the trend toward country-by-country reporting, but at a lower magnitude than large countries. Furthermore, small countries deviate from the general trend toward strict hybrid mismatch regimes, which can be observed at the international level (see, e.g., OECD BEPS Action 2), as well as exit taxes, which are designed to prevent the relocation of business functions. For the other *AntiTAScore* items, we do not observe noteworthy significant differences. However, this could be due to our conservative research design. Given that the time series variation of the individual *AntiTAScore* items is significantly lower than that of the full index, country and year fixed effects might already absorb a notable part of the variation.

4.3 Robustness and Sensitivity Tests

We subject our main results to three sets of robustness tests. We present robustness tests for the baseline regression in Table 6 and for the size split, using anti-tax avoidance rules as the dependent variable, in Table 7. In the first set of tests, we show that our results are robust to the use of variations in control variable choices.

[21] Note that we cannot estimate the role of technological changes in shaping disclosure regulation because of a lack of changes in this type of regulation among small countries. Country fixed effects absorb the (lack of) variation.

Specifically, our results are robust to the exclusion of lagged tax policy variables (Column (1) in Tables 6 and 7); to the inclusion of additional control variables for (a) a pro-market attitude of the government, (b) controls for world governance indicators, (c) FDI stock to proxy for the prevalence of multinationals, and (d) an indicator equal to one for the years in which a country is an OECD member (Column (2) in Tables 6 and 7); and to the exclusion of country-level control variables (Column (3) in Tables 6 and 7). The results show that coefficient estimates are very close to our baseline estimates, indicating that the choice of control variables does not alter our inferences much.

The second set of robustness tests addresses concerns about missing year fixed effects and the possibility that our trend variable does not fully capture the time trend in our sample countries. For this purpose, we include country-specific linear trends in our regressions. Again, we continue to find empirical support for our main results: technological changes appear to result in stricter anti-tax avoidance rules. This trend is shaped by larger countries, while smaller countries do not follow the trend of stricter anti-tax avoidance rules. Third, we rerun our baseline model in a change specification (without country fixed effects). Despite this relatively tight specification, we continue to find support for our main results. Fourth, we include a control for the difference between a country's own tax policy variable and the distance-weighted average of the other OECD countries, to control for the influence of neighboring countries' tax policies.

Another potential concern of our main regression approach is that our separate OLS regressions for each tax policy variable do not account for potential interdependence of the three considered tax policy tools. Since policymakers obviously do not set rates, investment incentives, and anti-tax avoidance rules in isolation, we run a panel vector autoregression (VAR) model that accounts for such interdependence. The VAR is fit using a one-step GMM estimation (Sigmund and Ferstl, 2019). The result from the regression—the impulse response function—for our three tax policy variables and the technology change variable are presented in Figure 8. On the vertical (horizontal) axis, we present the respective dependent (independent) variable. Consistent with our main finding, we document a significant and positive relation between lagged technological changes and anti-tax avoidance rules (upper right corner). Moreover, as in our main test, no stable and significant relation between technological change and other tax policy tools can be observed.

Finally, although our results suggest that technological changes act as an antecedent of tax policy changes, prior literature has often focused on the effect of tax policy changes on business decisions (for a review, see Hines 1997). Our measurement approach limits the chance of tax policy changes affecting technological change exposure for the following reasons. First, we identify technological changes based on large ICT job proportion changes in U.S. industries. Although we cannot rule out that international tax policy changes affect the job structure in the United States, we regard this rather unlikely. Second, we use a country's industry weights to project U.S. technological changes to the countries included in our sample and construct a measure of country-specific technological change exposure. Tax policies could, of course, affect a country's industry composition to some extent. However, since we examine lead-lag relations over three-year periods, industry importance is rather unlikely to change substantially within this time window.[22] Nevertheless, to test our conjectures, we examine whether changes in tax policies predict technological change exposure for large versus small countries. Our research design allows us to also test whether tax policy changes precede technological changes (Reinhart and Rogoff, 2011; Hail et al., 2018). To do so, we reverse the baseline estimation equation. Table 8 reports the results of this test. We only observe a significant and negative persistence parameter for technological change exposure. This finding suggests that technological changes are, to some extent, transitory. More importantly, we do not find significant results for the predictive ability of prior periods' investment incentives or anti-tax avoidance rules for technological changes. Considering only Table 8, we find an apparent relation between tax rates and technological changes. However, when considering the VAR model in Figure 8, we find no evidence of a robust relation between tax rates and future technological changes. Collectively, these findings give us confidence that our identification strategy allows us to isolate the sequential order of events.

4.4 Additional Tests

4.4.1 Firm-Level Tests: Tax Measures and Firm Outcomes

In the final set of tests, we try to better understand why larger countries tighten anti-tax avoidance rules while smaller countries refrain from doing so. Moreover, we are interested in why our sample countries and, in particular, small countries do not simply reduce taxes or increase investment incentives. To explore these questions, we examine the relation between our tax policy variables and investment, tax avoidance, and capital structure, using firm-level data from Compustat Global and Compustat North America. It is reasonable to expect the tightening of anti-tax avoidance rules to be associated with less tax avoidance. As tax avoidance decreases, firms face higher ETRs. This, in turn, can lead to lower investments (e.g., De Vito, Jacob, and Müller, 2019). Finally, when tax avoidance is reduced because of tighter anti-tax avoidance rules,

[22] At this point, we again refer to the depiction of our empirical strategy in Figure 6.

firms can seek other tax shields, for example, by increasing debt (e.g., Graham and Tucker, 2006). To test these three predictions, we use firm-level data from Compustat Global on all listed firms for our sample countries over our sample period.[23] We then estimate the following equation:

$$
\begin{aligned}
Firm\_Outcome_{i,j,t} = \beta_1 AntiTAScore_{i,t-1} + \beta_2 InvScore_{i,t-1} + \beta_1 StatTR_{i,t-1} \\
+ \boldsymbol{\Pi_{i,t}\psi} + \boldsymbol{\Gamma_{j,t}\phi} + \alpha_i + \gamma_t + u_{i,t}
\end{aligned}
\tag{2}
$$

where $Firm\_Outcome_{i,j,t}$ is one of three firm outcomes of firm i in country j in year t. First, we use $Investment_{i,j,t}$, defined as capital expenditures relative to the prior year's total assets, as the dependent variable. Second, we use $GAAP\_ETR_{i,j,t}$, which is the one-year Generally Accepted Accounting Principles (GAAP) ETR, as the dependent variable capturing a firm's tax avoidance. We use GAAP instead of cash ETRs as the dependent variable because of data coverage issues for the latter.[24] In addition to capturing immediate changes in the tax burden, we use the three-year GAAP ETR from t to $t + 2$ ($GAAP\_ETR\_3_{i,j,[t,t+2]}$) as the dependent variable. Third, we use the change in the leverage ratio ($\Delta Lev_{i,j,[t-1,t]}$) to proxy for changes in capital structure. Our main coefficients of interest are β_1 to β_3. These coefficients capture the correlations of our three tax policy measures, *AntiTAScore*, *InvScore*, and *StatTR*, in year $t - 1$ with firm outcomes.

We include several control variables in our regressions, following prior literature on investments (Baker et al., 2003; Becker, Jacob, and Jacob, 2013; Jacob, Wentland, and Wentland, 2018). The vector $\boldsymbol{\Pi_{i,t-1}}$ includes lagged firm-level controls for the level of cash holdings, leverage, Tobin's q, firm size, profitability, and growth in sales. These variables are included to control for firm-level investment incentives and the availability of funds. Second, we include the vector $\boldsymbol{\Gamma_{j,t-1}}$, which contains several country-level controls for overall economic conditions (GDP level, GPD growth, inflation, and a governance factor). We further include firm fixed effects (α_i) and region–industry–year fixed effects (γ_t) to ensure that we compare firms in the same industry, same IMF region, and same year. Our statistical inferences are based on robust standard errors clustered at the country level. All variables are winsorized at the 1% and 99% levels, with the exception of GAAP ETRs, which are winsorized at zero and one.

[23] Our sample restrictions follow prior literature (e.g., Baker, Stein, and Wurgler, 2003). We require firms to have non-negative cash holdings, sales, assets, equity, and capital expenditures. In the tax avoidance regressions, we require firms to have non-negative income.

[24] We cannot use the cash ETR, because cash taxes paid are not a mandatory reporting item in several countries.

Table 9 presents the regression results from estimating equation 2 for a sample of listed firms for which we could obtain information from Compustat Global and North America for 33 OECD countries. The results indicate an association between anti-tax avoidance rules and firm outcomes that can (partially) explain why some countries (e.g., large countries) increase anti-tax avoidance rules following technological changes while others (e.g., small countries) do not. Our results suggest that countries face a trade-off between investment, tax revenues, and firm riskiness: anti-tax avoidance rules are negatively associated with investments, but positively associated with ETRs and changes in leverage. The results in Table 9 further suggest that investment incentives and statutory tax rates are not associated with firm outcomes in our case. One potential explanation for this effect is that these incentives are measured in the headquarters' country, but operations can be in other countries. While this matters for investment incentives and the statutory tax rate, it is less relevant for anti-tax avoidance rules because the latter determine a firm's ability to reduce the company-wide ETR (which is then potentially relevant to the firm's investment decisions).

Collectively, the evidence in Table 9 suggests that one plausible explanation for the observed tightening of anti-tax avoidance rules in large countries is that these countries put more political weight on reducing tax avoidance and securing corporate tax revenues (as also evidenced by the anecdotal fact that the G20, i.e., the largest countries, initiated the OECD BEPS Project). Smaller countries appear to place more weight on incentivizing investment relative to collecting tax revenues, since they do not tighten anti-tax avoidance rules following technological changes.

4.4.2 Salience of Tax Policy Tools

Another explanation for why countries use less strict anti-tax avoidance rules instead of lower statutory tax rates to incentivize corporate investment relates to the lower salience of anti-tax avoidance rules. Tax rates are very salient and can easily be understood by the public (Chetty, Looney, and Kroft, 2009; Finkelstein, 2009). Therefore, tax rate cuts could be more likely to trigger undesired tax justice debates among the public. In contrast, anti-tax avoidance rules are complex and not well understood by the public. Anti-tax avoidance rules can hardly be expressed in an easily understood figure such as the statutory tax rate, making the evaluation of these rules very hard.

To provide anecdotal support for this notion, we examine newspaper attention to different reform items during the process of the 2017 U.S. tax reform. Figure 9 plots the monthly number of articles published in the top six U.S. newspapers on selected components of the 2017 U.S. tax reform. We consider articles published from November 1, 2017, until March 31, 2018, around the enactment of the reform. The number of articles is obtained via Factiva, using two different search phrases. The first search phrase (*tax rate* and *"21"* and *cut*) captures news articles referring to the salient tax rate cut from 35% to 21%. The second phrase ((*"GILTI" or "FDII"* or *base erosion*) and *tax*) captures articles on other less salient but also important tax reform changes tackling corporate tax avoidance. That is, we match articles that contain the term *tax* and one of the three terms *GILTI*, *FDII*, or *base erosion*. Comparison of the two article count series over the five-month period reveals a strong media focus on the tax rate change, while the policy changes in anti-tax avoidance rules received substantially less coverage. In each month (with non-zero mentions of anti-tax avoidance provisions), the tax rate cut received at least 83% more press coverage than the anti-tax avoidance provisions. This anecdotal evidence is consistent with our argument that countries can exploit less salient policy measures to set indirect investment incentives for firms.

5 Conclusion

We analyze the trends in OECD countries' corporate tax policy design over the past two decades and examine the role of technological changes in shaping corporate tax policy design. We measure tax policy via statutory tax rates, capital investment incentives, and anti-tax avoidance rules. While tax rates decline over our sample period, capital investment incentives remain stable, and anti-tax avoidance rules become stricter. Importantly, cross-country variation in tax rules does not decline over our sample period, despite several harmonization efforts at the international level. Exploiting a new measure of technological changes as a source of variation in tax policy, we provide evidence suggesting that countries compete via anti-tax avoidance rules when exposed to technological changes. Although, on average, countries seem to implement stricter anti-tax avoidance rules in response to technological change, larger countries seem to drive this trend. Smaller countries refrain from implementing additional anti-tax avoidance rules following technological changes.

Our results have important implications. First, our results are consistent with anti-tax avoidance rules being a potentially important way for smaller countries to attract investments. Our findings further suggest that traditional investment incentives (e.g., depreciation allowances) are not utilized for this purpose. Larger countries appear to put more weight on preserving corporate tax revenues, since they implement strict anti-tax avoidance rules in response to technological changes. Second, our results point toward the potential endogeneity of anti-tax avoidance rules. Empirical work exploiting changes in anti-tax avoidance rules should take into account their potential endogeneity with respect to technological changes.

We also acknowledge several limitations of our study. Our proxy for technological changes can only measure technological change on a coarse level. It thus suffers from measurement error. While we do not have a reason to suspect that this measurement error is correlated with a country's tax policy, a more precise proxy of technological changes would provide more power for statistical tests. Similar, our tax policy indexes are summary measures with some arguably arbitrary choices, such as giving similar weights to each item. Another potential limitation is that we can only examine the rules set by policymakers, but not the level of enforcement. However, our objective is to examine the determinants of corporate tax policy choices. An interesting and important avenue for future research is the analysis of the effectiveness and macroeconomic consequences of setting corporate tax policy along the three dimensions: tax rates, investment incentives, and anti-tax avoidance rules.

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Figure 1: Tax Policy Measure Variation

This figure plots the annual average of our tax policy measures (*StatTR*, *InvScore*, and *AntiTAScore*) for all 34 sample countries over the sample period (1996–2016). Annual interquartile ranges are depicted in gray to illustrate cross-sectional variation in the three tax policy measures.

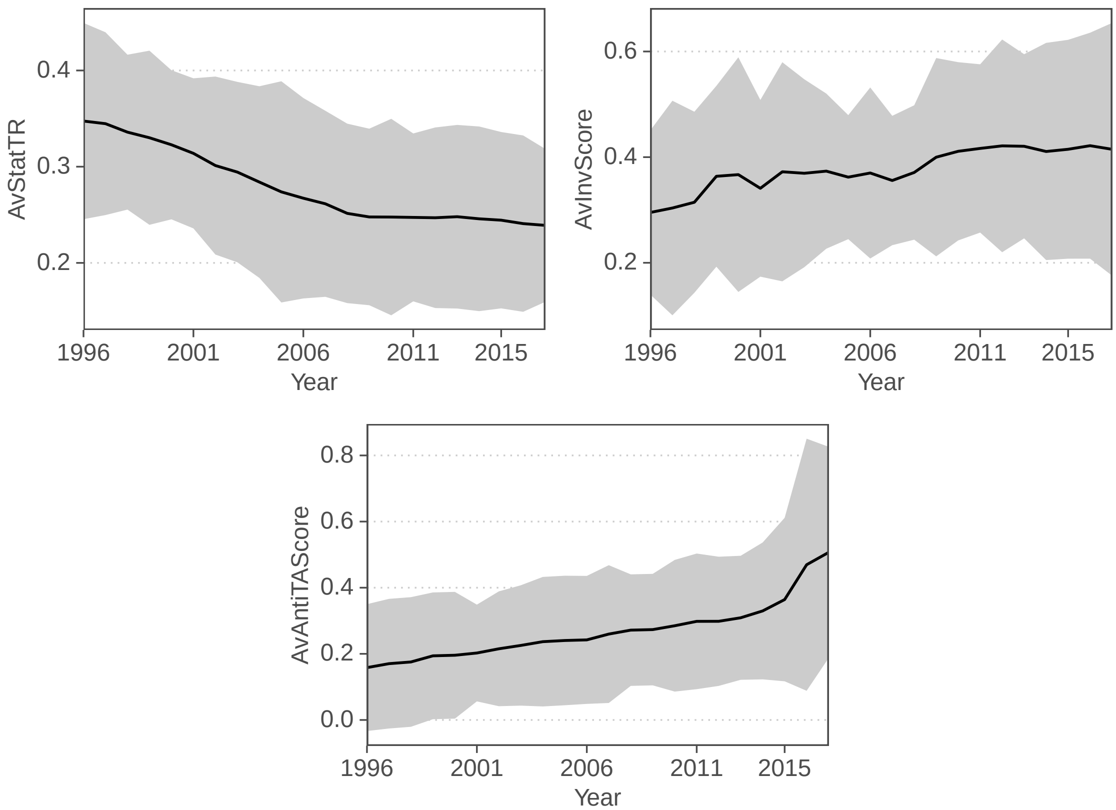

Figure 2: Corporate Statutory Tax Rate Development by Country

This figure depicts the statutory corporate tax rates for the 34 sample countries over the sample period (1996–2016). Data on statutory tax rates are from the OECD Stats database and the Ernst & Young *Corporate Tax Guides*.

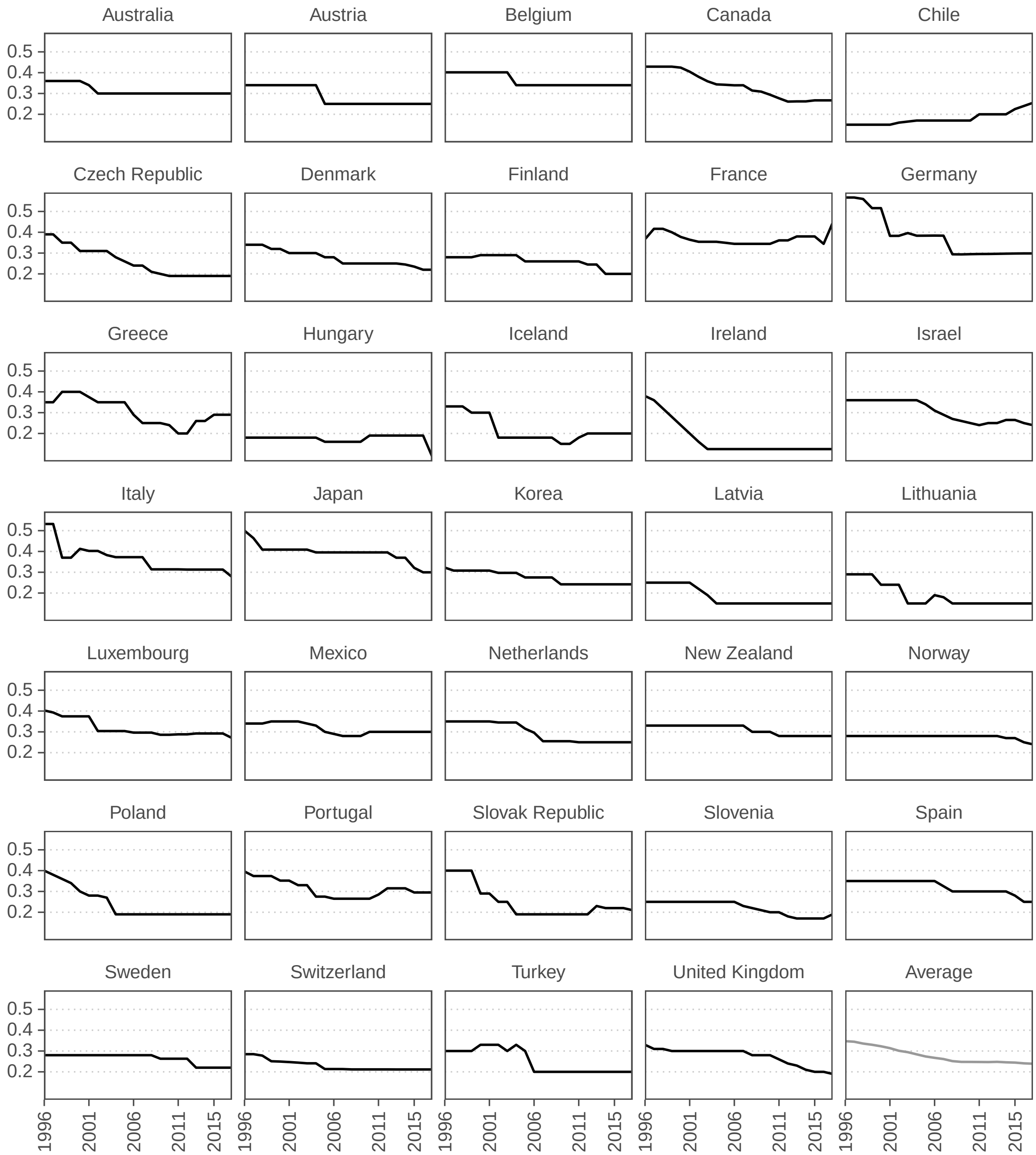

Figure 3: AntiTAScore and InvScore Levels, by Country

This figure depicts the levels of *AntiTAScore* and *InvScore* for the 34 sample countries over the sample period (1996–2016). Detailed information on index construction is included in Table 1. The underlying data are from the IBFD *European Tax Handbooks*, the PricewaterhouseCoopers *Corporate Taxes -– Worldwide Summaries*, the Ernst & Young *Corporate Tax Guides*, the OECD Stats database, and countries' official tax authority websites.

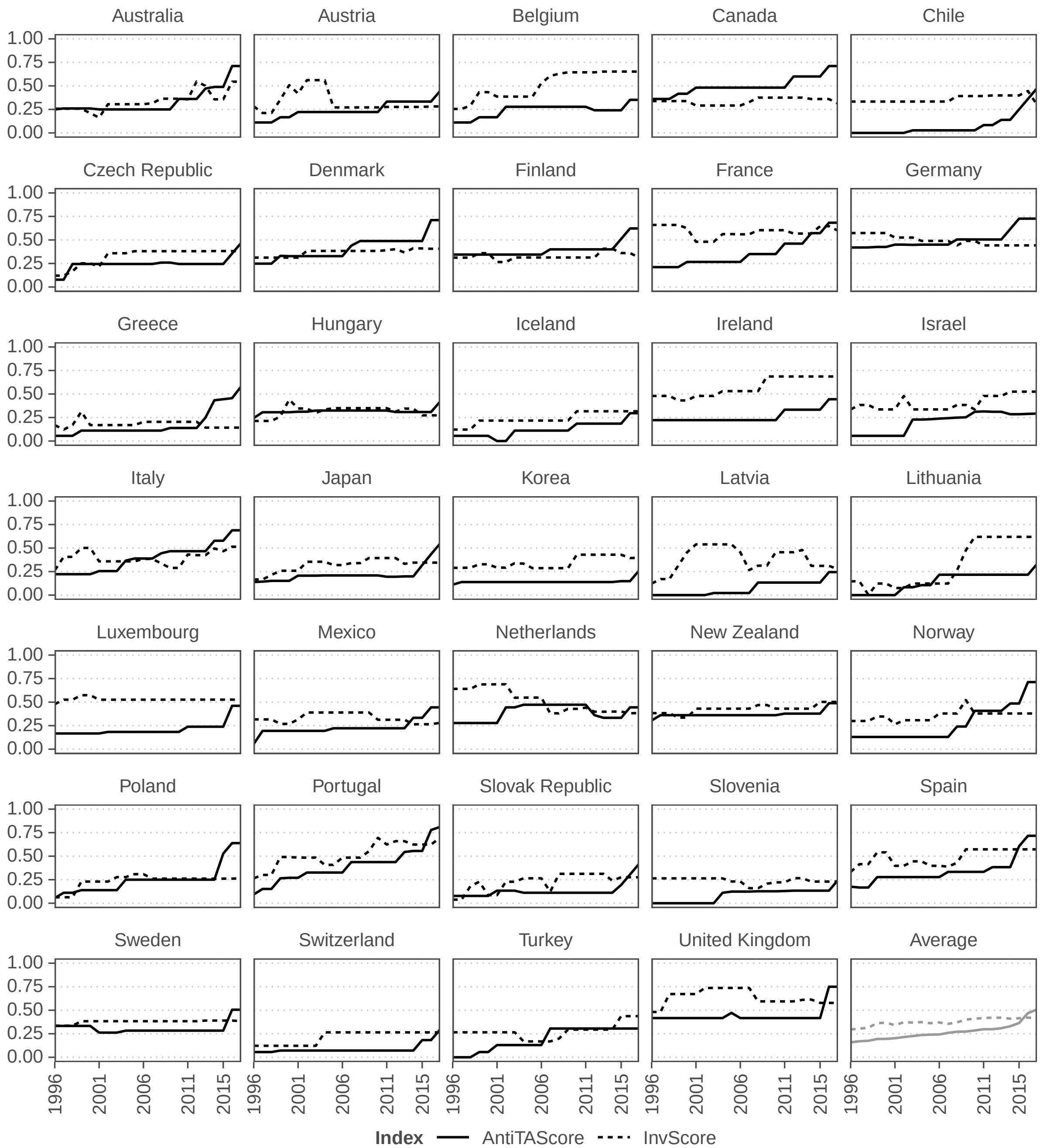

Figure 4: Large Technological Change Events, by U.S. Industry

This figure plots large technological change events for U.S. industries over the sample period (1996–2016). For each U.S. industry, we define a large technological change as an annual increase in the proportion of ICT jobs above the top quintile of the annual job changes distribution and that is not fully reversed over the subsequent period.

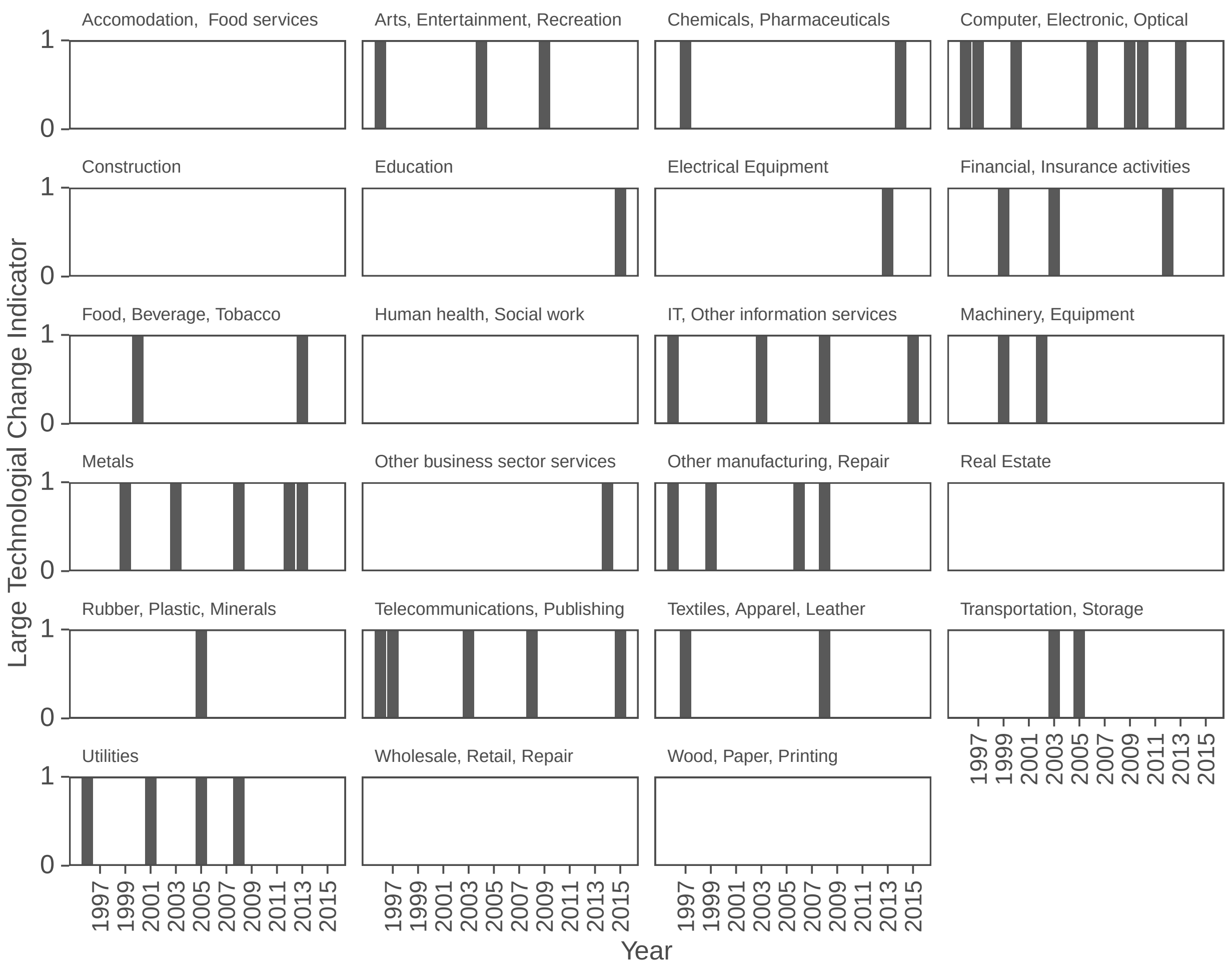

Figure 5: Variation in Technological Change Exposure, by Sample Country

This figure shows cross-sectional variation in exposure to U.S. technological changes. While the timing of the technological change events is the same for all countries, the exposure varies, depending on country-specific industry structures.

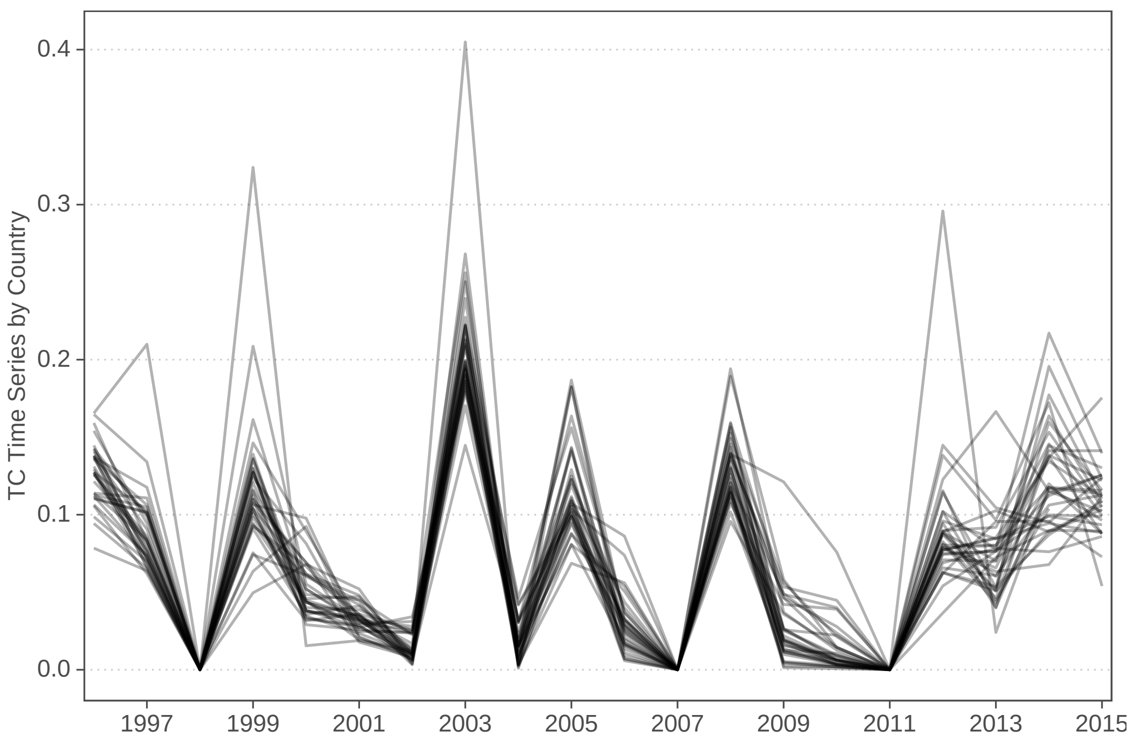

Figure 6: Depiction of the Empirical Strategy

Figure 6 illustrates the assumed temporal relation between our key variables of interest and potentially confounding factors (e.g., lagged U.S. tax policy or lagged institutional/economic characteristics).

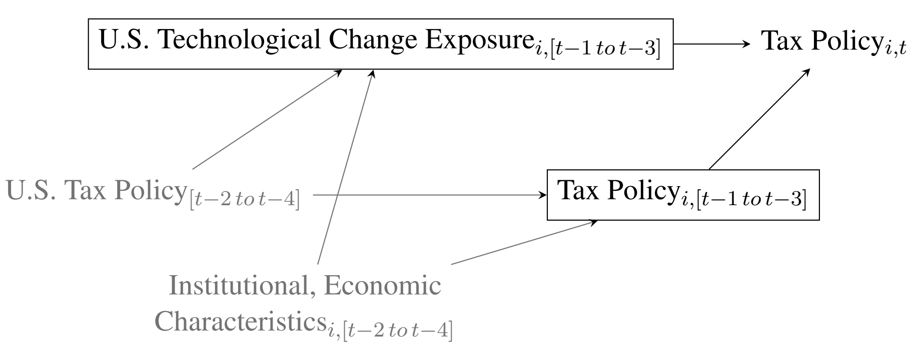

Figure 7: Average Tax Policy Levels, by Country Size

This figure depicts the average levels of statutory tax rates (*StatTR*), tax rules providing traditional investment incentives (*InvScore*), and anti-tax avoidance rules (*AntiTAScore*) by country size group. We use the tercile ranks of a country's population size to sort countries into three groups (*Small*, *Medium*, and *Large*).

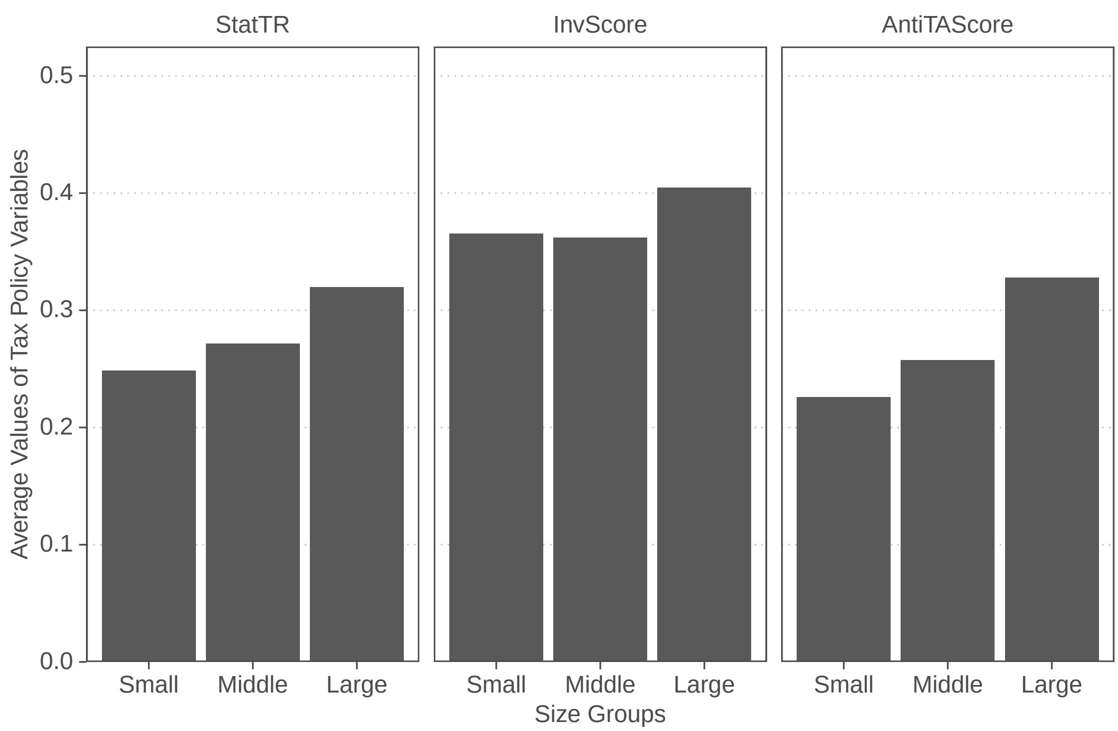

Figure 8: Generalized Impulse Response Functions from Panel VAR

This figure plots the generalized impulse response functions of a panel VAR of the form $y_t = a_i + a_1 y_[t-1] + a_2 y_[t-2] + a_3 y_[t-3] + controls + u$, where $y_t = [AntiTAScore_t, InvScore_t, StatTR_t, TC_t]$ is a vector and the controls are the same as in the main specification. The VAR is fit using one-step GMM estimation (Sigmund and Ferstl, 2019). The shaded regions are 95% confidence bands and are obtained by bootstrapping 500 samples.

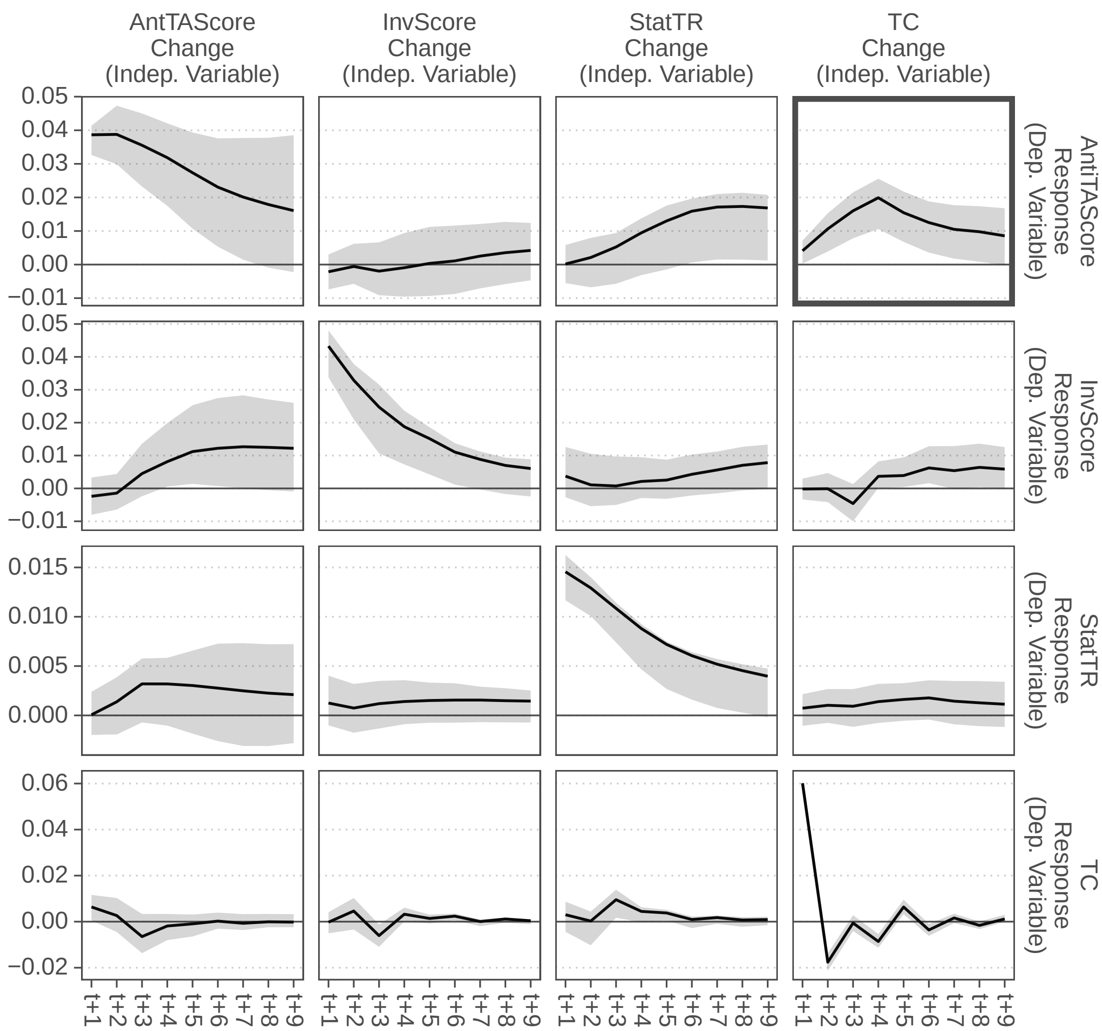

Figure 9: Number of Newspaper Articles around the 2017 U.S. Tax Reform

This figure plots the monthly number of newspaper articles published in either *The Wall Street Journal*, *The New York Times*, *Chicago Tribune*, *New York Post*, *Los Angeles Times*, or *The Washington Post* from November 1, 2017, until March 31, 2018. We used two different search phrases in Factiva: one related to the salient tax rate cut and one for other, less salient but also substantial tax reform changes related to tax avoidance. The explicit search phrases are outlined in Table 1.

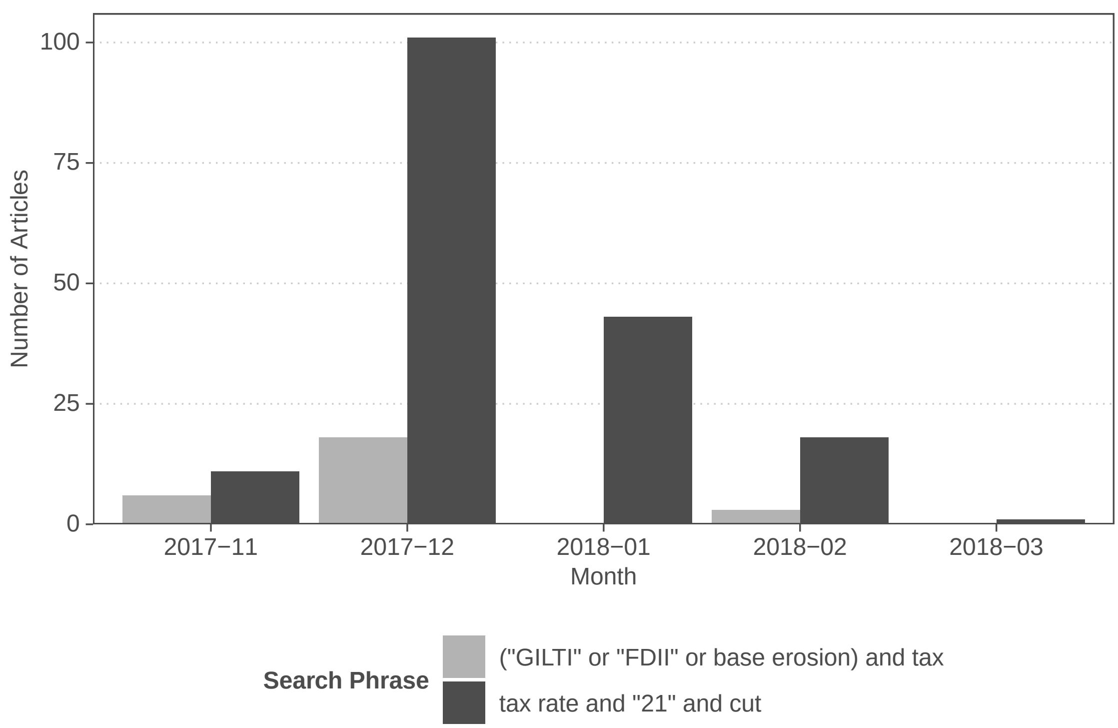

Table 1: Construction of Indexes

Item	Rating	Weight
Panel A: *InvScore*		
(1) Loss carryback rule	1 – Yes | 0 – No	1/7
(2) Loss carryforward measure[a]	Range between 0 and 1 depending on loss carryforward regime characteristics	1/7
(3) Group taxation regime	1 – Yes | 0 – No	1/7
(4) Corporate equity allowance	1 – Yes | 0 – No	1/7
(5) Venture capital tax benefits	1 – Yes | 0 – No	1/7
(6) Accelerated depreciation[b]	1 – Yes | 0 – No	1/21
(7) Immediate write-off option[b]	1 – Yes | 0 – No	1/21
(8) Bonus depreciation[b]	1 – Yes | 0 – No	1/21
(9) R&D tax incentives	1 minus adjusted B-index[c] (values normalized between 0 and 1)	1/7
Panel B: *AntiTAScore*		
(1) Hybrid mismatch rule	1 – Yes | 0 – No	1/9
(2) General anti-tax avoidance rule	1 – Yes | 0 – No	1/9
(3) Transfer pricing regime	0 – No regime effective; 0.5 – only arm's length principle; 1 – more complex transfer pricing rules	1/9
(4) Thin-capitalization regime strictness	1 minus debt-to-total assets ratio; 0 – if no regime	1/9
(5) Earnings-stripping rule strictness	1 minus earnings-stripping threshold (in percent); 0 – if no regime	1/9
(6) CFC regime strictness	Low-tax country threshold tax rate divided by statutory tax rate in the country of control	1/9
(7) Exit tax system	1 – Yes | 0 – No	1/9
(8) Tax-specific voluntary/mandatory disclosure regime	1 – Yes | 0 – No	1/9
(9) Installation of country-by-country reporting rules	1 – Yes | 0 – No	1/9

This table displays the construction of our two self-constructed tax policy indexes *InvScore* and *AntiTAScore*.

[a] Our loss carryforward measure follows the operationalization of Bethmann et al. (2018).

[b] We weight each of the three items referring to tax incentives related to tangible assets incentives with 1/21, to ensure the equal weighting of tangible and intangible tax incentives in our final score.

[c] The B-index formula follows that of McFetridge and Warda (1983); we make several simplifying assumptions for our adjusted B-index calculation (i.e., we assume constant tax rates, constant wage portions, constant portions of current expenses, and constant investments over time).

Table 2: Descriptive Statistics

Variable	N	Mean	StD	P05	P25	P50	P75	P95
Tax Policy Variables								
StatTR	578	0.27	0.07	0.15	0.20	0.28	0.31	0.38
AntiTAScore	578	0.28	0.15	0.06	0.15	0.26	0.37	0.51
InvScore	578	0.39	0.14	0.17	0.29	0.38	0.48	0.65
Technological Change Variables								
TC	578	0.07	0.06	0.00	0.01	0.05	0.11	0.19
$TC_{i,[t-1\,to\,t-3]}$	578	0.06	0.03	0.02	0.04	0.06	0.08	0.11
Split Variable								
Size	578	16.27	1.39	13.09	15.48	16.15	17.56	18.26
Controls								
$CapitalIn_{t-1}$	578	0.38	3.26	-5.89	-1.52	0.31	2.16	7.26
$ElYear_{t-1}$	578	0.25	0.44	0.00	0.00	0.00	1.00	1.00
$GDPGr_{t-1}$	578	2.48	3.28	-3.55	1.14	2.62	4.04	7.10
$GovExppGDP_{t-1}$	578	34.01	9.65	17.05	28.46	35.95	41.12	47.13
$lnGDPpCapUSD_{t-1}$	578	10.36	0.39	9.63	10.11	10.44	10.62	10.91
$Unemp_{t-1}$	578	7.90	4.21	3.21	4.82	7.06	9.79	16.21

This table presents descriptive statistics for the final sample in our analyses. See Table A.1 in the Appendix for a detailed description of the computation for each variable.

Table 3: Average Predictive Ability of Technological Changes

	StatTR (1)	InvScore (2)	AntiTAScore (3)
StatTR$_{[t-1\,to\,t-3]}$	0.706^{***}		
	(0.041)		
InvScore$_{[t-1\,to\,t-3]}$		0.732^{***}	
		(0.061)	
AntiTAScore$_{[t-1\,to\,t-3]}$			0.900^{***}
			(0.061)
$TC_{[t-1\,to\,t-3]}$	-0.012	0.016	0.402^{***}
	(0.032)	(0.076)	(0.104)
GovExppGDP$_{t-1}$	0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)
GDPGr$_{t-1}$	0.000	-0.003^{**}	0.001
	(0.000)	(0.001)	(0.001)
Unemp$_{t-1}$	0.001	0.000	0.000
	(0.001)	(0.002)	(0.002)
ElYear$_{t-1}$	0.003^{**}	0.000	0.000
	(0.002)	(0.004)	(0.004)
CapitalIn$_{t-1}$	-0.000	-0.000	0.001
	(0.000)	(0.001)	(0.001)
lnGDPpCapUSD$_{t-1}$	0.017	0.006	-0.074^{**}
	(0.015)	(0.126)	(0.037)
Year	-0.001^{**}	-0.000	0.005^{***}
	(0.000)	(0.002)	(0.001)
Country cluster	Yes	Yes	Yes
Observations	578	578	578
Adjusted R^2	0.929	0.836	0.895
Within R^2	0.741	0.476	0.686

This table reports the regression results for our analysis of the lead-lag relation between our technological change proxy ($TC_{[t-1\,to\,t-3]}$) and our three tax policy measures. The dependent variables are the level of statutory tax rates (*StatTR*), our index capturing tax-induced investment incentives (*InvScore*), and our index capturing the strictness of anti-tax avoidance rules (*AntiTAScore*). The key explanatory variable ($TC_{[t-1\,to\,t-3]}$) measures country-specific exposure to large technological changes. See Table A.1 in the Appendix for a detailed description of the definition and computation of each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Predictive Ability of Technological Changes, by Country Size

	StatTR (Large)	StatTR (Small)	Diff	InvScore (Large)	InvScore (Small)	Diff	AntiTASc. (Large)	AntiTASc. (Small)	Diff
$TC_{[t-1\,to\,t-3]}$	0.016	0.020	−0.004	0.152	−0.039	0.191	0.775***	0.185*	0.590**
	(0.081)	(0.046)	(0.091)	(0.135)	(0.116)	(0.174)	(0.233)	(0.109)	(0.252)
Controls	Yes	Yes		Yes	Yes		Yes	Yes	
Country fixed effects	Yes	Yes		Yes	Yes		Yes	Yes	
Observations	184	201		184	201		184	201	
Adjusted R^2	0.919	0.905		0.875	0.827		0.888	0.906	
Within R^2	0.756	0.723		0.307	0.592		0.732	0.736	

This table reports the regression results for the lead-lag relation between our three tax policy measures and technological change exposure when considering only large and small countries. We sort countries into terciles based on their average population size over the sample period. We then provide the results for the top tercile subsample of (large) countries and the bottom tercile subsample of (small) countries. See Table A.1 in the Appendix for a detailed description of the definition and computation of each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Predictive Ability of Technological Changes for $AntiTAScore$ Components

	HybMisRul	GAAR	TransPric	ThinCap Strictness	EarnStrip Strictness	CFC Strictness	CbC Reporting	ExitTax	DiscReg
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Large Countries									
$TC_{[t-1\,to\,t-3]}$	3.477^{***}	0.307	-0.496^{*}	0.557^{**}	-0.886	0.256	3.074^{***}	1.635^{*}	0.651
	(1.072)	(0.330)	(0.274)	(0.242)	(0.659)	(0.439)	(0.691)	(0.909)	(0.432)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	C	C	C	C	C	C	C	C	C
Country cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	184	184	184	184	184	184	184	184	184
Adjusted R^2	0.571	0.919	0.427	0.444	0.606	0.934	0.258	0.813	0.078
Within R^2	0.406	0.188	0.208	0.053	0.391	0.148	0.231	0.285	-0.012
Panel A: Small Countries									
$TC_{[t-1\,to\,t-3]}$	-0.093	-0.258	-0.024	0.072	0.159	0.004	1.507^{***}	-0.646	–
	(0.784)	(0.535)	(0.650)	(0.126)	(0.236)	(0.313)	(0.567)	(0.550)	–
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	201	201	201	201	201	201	201	201	201
Adjusted R^2	0.470	0.887	0.694	0.783	0.218	0.867	0.170	0.840	-
Within R^2	0.147	0.095	0.431	0.060	0.087	0.172	0.158	0.208	-

This table shows separate regressions for all nine *AntiTAScore* items. Because the subcomponents have significantly less time variation than the aggregate *AntiTAScore*, we do not include a lagged dependent variable as a control. The difference between the $TC_{[t-1\,to\,t-3]}$ coefficients of the large and small country subsamples is statistically significant at the 10% level. Table 1 contains information on index construction and the nine elements used as dependent variables in this analysis. See Table A.1 in the Appendix for a detailed description of the computations for each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Robustness Tests for the Predictive Ability of Technological Changes

	No lagged Y	Additional Controls	Without Controls	Country-Specific Trend	Changes Regression	With Neighbor Policies
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Statutory Tax Rates						
$TC_{[t-1\,to\,t-3]}$	0.045	0.025	-0.021	-0.018	-0.013	0.036
	(0.044)	(0.042)	(0.032)	(0.037)	(0.023)	(0.027)
Panel B: Investment Score						
$TC_{[t-1\,to\,t-3]}$	-0.072	0.109	-0.072	-0.008	0.116^{**}	-0.046
	(0.081)	(0.088)	(0.088)	(0.073)	(0.046)	(0.047)
Panel C: Anti-Tax Avoidance Score						
$TC_{[t-1\,to\,t-3]}$	0.409^{***}	0.391^{***}	0.418^{***}	0.429^{***}	0.266^{***}	0.476^{***}
	(0.118)	(0.137)	(0.103)	(0.108)	(0.073)	(0.094)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	578	578	578	578	578	578

This table tests the robustness of the main results in Table 3. In Column (1), the results are repeated but the lagged dependent variable has been omitted; in Column (2), controls for the pro-market attitude of the government in power, controls for the World Governance Index, FDI stock to control for the presence of multinationals, and an interaction for OECD newcomer status have been added; in Column (3), all controls have been removed; in Column (4), a country-specific linear trend has been included; in Column (5), we use a first difference specification that regresses changes in the tax policy variable on technological change and controls; and, in Column (6), a control has been added for the difference between a country's tax policy and the distance-weighted average of its neighbors. Table A.1 in the Appendix provides the definition and computation of each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Robustness Tests for the Predictive Ability of Technological Changes, by Country Size

	No lagged Y	Additional Controls	Without Controls	Country-Specific Trend	Changes Regression	With Neighbor Policies
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Anti-Tax Avoidance Score (Large Countries)						
$TC_{[t-1\,to\,t-3]}$	0.953^{***}	0.593^{**}	0.773^{***}	0.746^{***}	0.409^{**}	0.756^{***}
	(0.192)	(0.248)	(0.268)	(0.252)	(0.168)	(0.205)
Country cluster	Yes	Yes	Yes	Yes	Yes	Yes
Observations	184	184	184	184	184	184
Panel B: Anti-Tax Avoidance Score (Small Countries)						
$TC_{[t-1\,to\,t-3]}$	0.080	0.144	0.223^{**}	0.226^{*}	0.226^{**}	0.269^{**}
	(0.108)	(0.112)	(0.100)	(0.116)	(0.099)	(0.128)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	201	201	201	201	201	201

This table reports the results of robustness tests for the size split in Table 4. In Column (1), the results are repeated but the lagged dependent variable has been omitted; in Column (2), controls for the pro-market attitude of the government in power, controls for the World Governance Index, FDI stock to control for the presence of multinationals, and an interaction for OECD newcomer status have been added; in Column (3), all controls have been removed; in Column (4), a country-specific linear trend has been included; in Column (5), we use a first difference specification that regresses changes in the tax policy variable on technological change and controls; and, in Column (6), a control has been added for the difference between a country's tax policy and the distance-weighted average of its neighbors. Table A.1 in the Appendix provides the definition and computation of each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Predictive Ability of Tax Policy Changes for Technological Changes

	TC (1)	TC (2)	TC (3)
$TC_{[t-1\,to\,t-3]}$	-0.646^{***}	-0.640^{***}	-0.641^{***}
	(0.061)	(0.062)	(0.061)
$StatTR_{[t-1\,to\,t-3]}$	0.204^{***}		
	(0.066)		
$InvScore_{[t-1\,to\,t-3]}$		0.006	
		(0.035)	
$AntiTAScore_{[t-1\,to\,t-3]}$			-0.043
			(0.062)
$GovExppGDP_{t-1}$	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
$GDPGr_{t-1}$	0.004^{***}	0.004^{***}	0.004^{***}
	(0.001)	(0.001)	(0.001)
$Unemp_{t-1}$	0.002	0.001	0.001
	(0.001)	(0.001)	(0.001)
$ElYear_{t-1}$	0.006	0.005	0.005
	(0.005)	(0.005)	(0.005)
$CapitalIn_{t-1}$	-0.000	-0.000	-0.000
	(0.002)	(0.002)	(0.002)
$lnGDPpCapUSD_{t-1}$	-0.060^{**}	-0.079^{**}	-0.080^{***}
	(0.024)	(0.031)	(0.024)
Year	0.003^{***}	0.002^{***}	0.002^{**}
	(0.001)	(0.001)	(0.001)
Country fixed effects	Yes	Yes	Yes
Observations	578	578	578
Adjusted R^2	0.058	0.049	0.050
Within R^2	0.037	0.028	0.029

This table reports the results of the reverse regression. The dependent variable is technological changes in period t. The key explanatory variables are our three tax policy measures (*StatTR*, *InvScore*, and *AntiTAScore*). See Table A.1 in the Appendix for a detailed description of the computations for each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Firm Outcomes and Tax Measures

	Investment (1)	GAAP_ETR (2)	GAAP_ETR_3 (3)	ΔLev (4)
AntiTAScore	-0.0160^{**}	0.2205^{**}	0.3930^{***}	0.0259^{***}
	(0.0072)	(0.0971)	(0.1323)	(0.0076)
InvScore	-0.0007	0.0751	0.0606	-0.0094
	(0.0088)	(0.0792)	(0.0662)	(0.0090)
StatTR	-0.0131	0.1157	-0.1591	-0.0336
	(0.0396)	(0.1312)	(0.1893)	(0.0219)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Region–industry–year FE	Yes	Yes	Yes	Yes
Observations	47,139	45,200	44,128	47,139
Adjusted R^2	0.538	0.445	-0.000	0.615

This table presents regression results on firm behavior in OECD countries. The dependent variable is capital investment relative to the prior year's total assets ($Investment$) in Column (1), the one-year GAAP ETR ($GAAP\_ETR$) in Column (2), the three-year GAAP ETR from t to $t+1$ ($GAAP\_ETR\_3$) in Column (3), and change in the ratio of debt to total assets from $t-1$ to t (ΔLev) in Column (4). All the independent variables are measured at $t-1$. In all columns, we include control variables, firm fixed effects, and region–industry–year fixed effects. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Appendix: Variable Construction

Table A.1: Variable Descriptions

Variable	Description
AntiTAScore	Annual index capturing the strictness of anti-tax avoidance rules. See Table 1 for an explanation of the index components and their weighting.
InvScore	Annual index capturing tax rules providing investment incentives. See Table 1 for an explanation of the index components and their weighting.
StatTR	Annual statutory tax rate. Data are from the OECD Stats database and the Ernst & Young *Corporate Tax Guides*.
TC	Weighted exposure to large technological changes in a U.S. industry j ($T_{j,t}$), where $T_{j,t} = 1$ if $\triangle ICTJobs_{j,t} > Q80$ and $\triangle ICTJobs_{j,t+1} > -Q80$, and 0 otherwise, and $Q80$ is the 80th percentile (top quintile) of the $\triangle ICTJobs_{j,t}$ distribution. We measure the technological change exposure of country i by weighting $T_{j,t}$ with industry j's weight (value added) in country i: $TC_{i,t} = \sum_j T_{j,t} * IndustryWeight_{i,j,t} / \sum_j IndustryWeight_{i,j,t}$
CapitalIn	Capital inflows from direct investment (% of GDP); consists of the sum of FDI net inflows (World Bank data code BX.KLT.DINV.WD.GD.ZS) minus FDI net outflows (World Bank data code BM.KLT.DINV.WD.GD.ZS). We winsorize the values at the 1% and 99 percentiles.
ElYear	Indicator for election years, with data obtained via progov.org.
GDPGr	GDP growth (OECD national accounts).
GovExppGDP	Government expenses for operating activities (% of GDP).
lnGDPpCap	Logarithm of the GDP per capita (OECD national accounts).
Population	Country population (World Bank data code SP.POP.TOTL).
Size	Logarithm of the population of a country, averaged over all years.
Unemp	Unemployment (% of labor force, World Bank data code SL.UEM.TOTL.ZS).
Robustness Test Variables	
ProState	Index of the pro-state versus pro-market leaning of the governing party, data obtained via progov.org.
PC1Wgi	First principal component of the World Bank World Governance Indicators.
FDIStock	Sum of FDI inflow and outflow stock as a % of GDP (United Nations UNCTAD data).
DiffAntiTAScore	*AntiTAScore* minus the distance-weighted average of all the other OECD countries' *AntiTAScore*, where the distance is measured between capitals.
DiffInvScore	*InvScore* minus the distance-weighted average of all the other OECD countries' *invScore*, where the distance is measured between capitals.
DiffStatTR	*StatTR* minus the distance-weighted average of all the other OECD countries' *StatTR*, where the distance is measured between capitals.

Table A.2: Occupations and Industries Used to Construct Job Proportions

Panel A: Census Occupations Labeled as ICT related

Code	Description
110	Computer and information systems managers
1000	Computer scientists and systems analysts/network systems analysts/web developers
1010	Computer programmers
1020	Software developers, applications and systems software
1050	Computer support specialists
1060	Database administrators
1100	Network and computer systems administrators
1200	Actuaries
1220	Operations research analysts
1230	Statisticians
1240	Mathematical science occupations
1400	Computer hardware engineers
2900	Broadcast and sound engineering technicians and radio operators, and media and communication equipment workers, all others
5030	Communications equipment operators, all others
5800	Computer operators
7900	Computer control programmers and operators

Panel B: ISIC4 industries

Code	Description	Code	Description
D01T03	[X] Agriculture, forestry and fishing	D35T39	Utilities
D05T09	[X] Mining	D41T43	Construction
D10T12	Food, Beverage, Tobacco	D45T47	Wholesale, Retail trade, Repair motor vehicles
D13T15	Textiles, Apparel, Leather	D49T53	Transportation, Storage
D16T18	Wood, Paper, Printing	D55T56	Accommodation, Food services
D19	[X] Coke, Petroleum	D58T61	Telecommunications, Publishing, Broadcasting
D20T21	Chemicals, Pharmaceuticals	D62T63	IT, Other information services
D22T23	Rubber, Plastic, Minerals	D64T66	Financial, Insurance activities
D24T25	Metals	D68	Real Estate
D26	Computer, Electronic, Optical	D69T82	Other business sector services
D27	Electrical Equipment	D85	Education
D28	Machinery, Equipment	D86T88	Human health, Social work
D29T30	Motor vehicles, Transport equipment	D90T96	Arts, Entertainment, Recreation, Other
D31T33	Other manufacturing, Repair and installation		

Table A.2 displays occupation codes and industry aggregation levels used for constructing our technological change measure. Occupation codes in Panel A are U.S. Census occupation codes. Panel B industry codes are the International Standard Industrial Classification for all Economic Activities codes (fourth revision). Industries marked [X] were not used for weighting.

Table A.3: Other Definitions of Large Technology Changes

	(1)	(2)	(3)
Panel A: StatTR as the Dependent Variable			
$TC_{[t-1\,to\,t-3]}$ *(Quartile)*	-0.012		
	(0.032)		
$TC_{[t-1\,to\,t-3]}$ *(Decile)*		-0.163^{**}	
		(0.066)	
$TC_{[t-1\,to\,t-3]}$ *(IOWtd)*			$0.042*$
			(0.023)
Panel A: InvScore as the Dependent Variable			
$TC_{[t-1\,to\,t-3]}$ *(Quartile)*	-0.053		
	(0.077)		
$TC_{[t-1\,to\,t-3]}$ *(Decile)*		-0.165	
		(0.177)	
$TC_{[t-1\,to\,t-3]}$ *(IOWtd)*			-0.051
			(0.058)
Panel C: AntiTAScore as the Dependent Variable			
$TC_{[t-1\,to\,t-3]}$ *(Quartile)*	0.085^{*}		
	(0.051)		
$TC_{[t-1\,to\,t-3]}$ *(Decile)*		0.368^{***}	
		(0.108)	
$TC_{[t-1\,to\,t-3]}$ *(IOWtd)*			0.196^{***}
			(0.067)
Country cluster	Yes	Yes	Yes
Observations	578	578	578

This table reports the results of robustness tests of the size split results in Table 4. In Column (1), we use the top quartile of the changes in ICT jobs—instead of the fifth quintile—as the threshold for large technological changes. In Column (2), we use the 10th decile as a threshold. In Column (3), we use OECD input–output tables as additional information to determine how important a U.S. industry is as a business partner to another country's industry. Table A.1 in the Appendix provides the definition and computation of each variable. We report robust standard errors clustered at the country level in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

TRR 266 Accounting for Transparency

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