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Corporate Tax Avoidance and Sales: Micro Evidence and Aggregate Implications

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Corporate tax avoidance and sales: micro evidence and aggregate implications *

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Abstract

This paper investigates the influence of corporate tax avoidance (CTA) on firm-level sales, and its aggregate implications. CTA gives a competitive advantage to avoiding firms, which affects the distribution of sales in the economy. We find a causal impact of CTA on sales in US firm-level data. CTA increased more among the largest firms, which has reinforced their dominant position. A quantitative exercise reveals that the strength of CTA in shaping changes in the distribution of sales varies across industries. In industries like computers or chemicals, CTA can explain up to 10%-30% of the increase in concentration from 1994 to 2017. Further analysis shows the impact of CTA-induced distortions on industrial output is relevant at a macroeconomic scale.

JEL codes: D22, H26, L11, D4, F23

Keywords: Tax Avoidance, Distorted Sales, Industry Concentration, IRS Audit Probability.

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There are high profit, high wealth corporations that are paying very little in taxes. Change must happen at the international level to avoid unfair competition. Gita Gopinath, Chief economist of the IMF (IMF, World Bank, OECD conference, September 2020).

1 Introduction

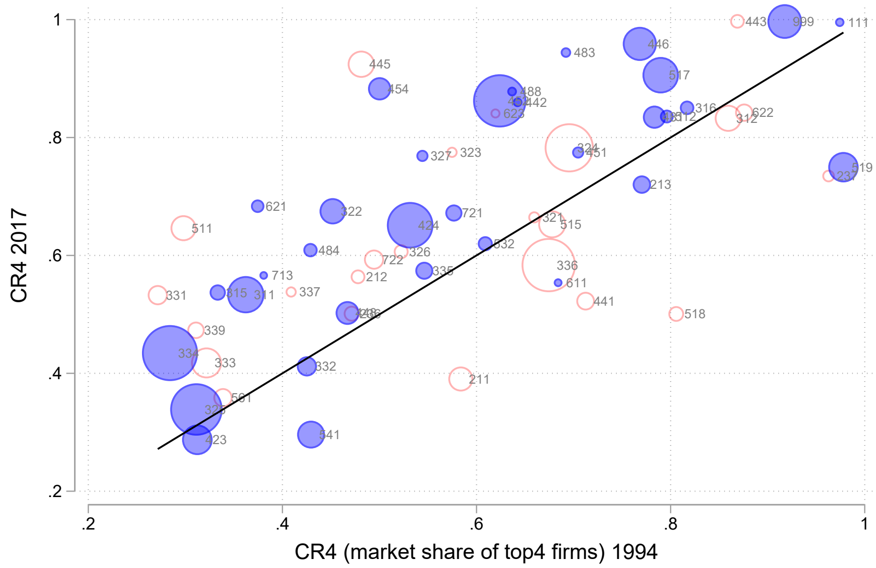
The increase in the concentration of economic activities across many industries in the U.S. and other developed countries is well-documented.[1] At the same time, tax planning practices of large companies have received considerable policy attention, as highlighted in the epigraph. This paper examines whether these tax planning practices have contributed to the upward trend in concentration.

We hypothesize that large firms engage in tax planning to a greater extent than their smaller counterparts, which increases industry concentration. In Figure 1, we compare the market share of the four largest firms (measured by the four-firm concentration ratio) across industries between 1994 and 2017, highlighting the industries in which the tax planning of the four largest firms has increased relative to smaller firms (blue circles). To measure firms' tax planning, we rely on the vast literature in accounting that has developed measures of what this literature refers to as "corporate tax avoidance". Corporate tax avoidance (CTA) is a broad concept that encompasses any deviation between what firms pay and what they would pay if the U.S. statutory corporate tax rate were applied to their pre-tax book income.[2] The figure shows that in many industries in the U.S., the CTA of the four largest firms has increased more than that of their competitors. This is especially valid in industries that have undergone a rise in concentration.

[1] The trend in U.S. industry concentration is discussed in Grullon et al. (2019), Furman and Orszag (2015), Philippon (2019), and Shambaugh et al. (2018). See Affeldt et al. (2021), or Bighelli et al. (2022) for evidence of increased concentration in European markets.

[2] Tax avoidance refers to a broad spectrum of activities that can include exploiting uncertainties or variability in the interpretation of tax law, engaging in legal tax planning, or using illegal arrangements to reduce taxable income (Hanlon and Heitzman, 2010; Chen et al., 2010). For recent discussions on the spread and magnitude of tax avoidance, see Dyreng et al. (2017), Blouin and Robinson (2019), and Clausing (2016; 2020a).

Figure 1: Industry concentration and tax avoidance in the U.S. (1994-2017)



Notes: Each circle is a NAICS 3-digit industry. Coordinates report the share of sales made up by the four largest firms in the industry (CR4). The size of the circle is proportional to the weight of the industry in the economy. Blue circles are industries in which the tax avoidance of the four largest firms has increased relative to small firms. Hollow circles are sectors in which the tax avoidance of the four largest firms has decreased relative to small firms. An increase (a decrease) in the relative tax avoidance of large firms is associated with an increase in (a reduction in) industry concentration in 31 out of 50 industries, accounting for 73% of aggregate sales.

To expand on this evidence, we proceed in two steps. We first demonstrate that CTA gives a competitive edge to avoiding firms, which results in higher sales. To assess the causal impact of CTA on sales, we take advantage of the fact that part of tax avoidance is driven by the manipulation of tax loopholes and legal complexities and is thus subject to the toughness of corporate tax enforcement (Hoopes et al., 2012). We then explore the macro implications of the positive impact of CTA on sales. CTA increased more among the largest firms, reinforcing their dominant position. The quantitative exercise then reveals that the strength of CTA in shaping changes in sales distribution varies across industries. In industries like computers or chemicals, CTA alone can explain up to 10%-30% of the increase in concentration from 1994 to 2017. Further analysis shows that the impact of CTA-induced distortions on industrial output is relevant at a macroeconomic scale.

Our analysis shows that laxer tax enforcement for large firms has contributed to distorting competition and reinforcing concentration across U.S. industries. A key implication of these findings beyond the U.S. context is that corporate taxation and competition policy are intertwined.

We organize our analysis around three main building blocks. The first block (section 2) provides a theoretical framework that clarifies the intuition for our mechanism and guides our empirical analysis and quantitative exercises. We develop a stylized model of imperfect competition that identifies the impacts of tax avoidance on firm-level sales. In the model, firms are heterogeneous regarding productivity and ability to reduce reported pre-tax profits. Profit-maximizing sales are distorted when firms can increase the production costs for calculating their income tax liability. In turn, lower effective taxation allows avoiding firms to expand their activity. In the model, this mechanism is captured by the negative impact of tax avoidance on *effective* marginal costs. We use the model to derive two industry-level implications. First, we show that the competitive edge offered by tax avoidance becomes relevant for industry concentration as soon as firms differ in tax-avoidance intensity. If tax avoidance were facilitated uniformly, firms' profitability could increase, but their relative sales would not be affected. Instead, if some firms adopt more aggressive tax-avoidance strategies, they grow larger, which changes sales distribution. Second, we aggregate firm-level output and investigate the impact of tax avoidance on efficiency. Our model draws a link between production, firms' productivity, and CTA. We show that heterogeneous CTA across firms distorts production allocation within industries. This simple model also provides some guidance on other factors that influence sales at the firm level.

In the second block (sections 3 to 4), we establish the causal impact of tax avoidance on sales in the Compustat dataset. We follow the methodology of Henry and Sansing (2018) to measure tax avoidance. Henry and Sansing's CTA index has the main advantage of considering the firm's loss years. It allows us to avoid selection bias when pre-tax income is negative, which is the case for our sample for about 38% of firm-year observations. We use individual fluctuations in audit probability over time and across firms as an instrument for Henry and Sansing's CTA index. This strategy is inspired by Hoopes et al. (2012), who find a negative correlation between IRS audit probability and corporate tax avoidance.[3] Since the IRS tends to conduct more audits on larger companies, we calculate *residual audit probabilities* to remove the mechanical correlation between audit probabilities and firm size. Our first-stage results show a negative correlation between the residual audit probability and tax avoidance. The second-stage estimates show a positive impact of aggressive tax-avoidance strategies on firms' sales. These findings are robust to the inclusion of factors that have proven to be important in the literature, such as the level of productivity, the share of intangible assets, the likelihood of acquisition, the firm's multinational status, the *R&D* intensity, and the lobbying efforts related to taxation issues. Additionally, our specifications incorporate sector-specific or firm-specific fixed effects and year-fixed effects, which eliminate the possibility of confounding factors that could be driving both tax avoidance and sales. We obtain similar results when using alternative identification strategies that take advantage of changes in U.S. regulations, which provide greater incentives for multinational corporations to engage in tax avoidance.

In the third block (sections 5 and 6), we quantify the macro-implications of tax avoidance on sales. We build upon our theoretical framework and estimates of the impact of avoidance on sales to gauge the contribution of tax avoidance to the increasing dominance of large firms. Our main takeaway from this exercise is that the change in tax avoidance alone between 1994 and 2017 explains about 6% of the increase in concentration (as measured by the four-firm concentration ratio – CR4) on average. The impacts, however, are highly heterogeneous across industries. For example, in some industries, such as chemicals, non-store retailers, air transportation, or the manufacturing of electronic products, tax avoidance alone explains about 25% of the increase in the market share of the four largest firms. Last, we assess the potential impact of tax avoidance on real production. To do so, we build on our simple model and develop a new methodology that remains agnostic about other distortions. In a second-best world, tax avoidance might decrease or increase real output.

[3] See also Nessa et al. (2020) and De Simone et al. (2019) on the role of tax enforcement in curbing opportunities for tax avoidance.

We show how to derive the upper and lower bounds of real-output change implied by CTA changes between 1994 and 2017. We find movements in CTA can induce swings in industries' output ranging from a drop of 6% to an increase of 5%. We find important effects in many industries, such as chemical manufacturing, electronic products, or non-store retailers, where CTA-induced concentration was prominent. Our quantitative exercise points to a sizeable impact of corporate tax policy on real output.

In addition, to the works cited above, we contribute to different strands of the literature. The tax-planning channel has been overlooked so far by the literature on the drivers of industry concentration, which has discussed the role of technology (Autor et al., 2020), intangible capital (Crouzet and Eberly, 2019; Bajgar et al., 2021), increasing barriers to entry, lax or ineffective antitrust enforcement (Gutiérrez and Philippon, 2018; Philippon, 2019).[4] In this paper, we document that tax avoidance gives a competitive edge to large profit-shifting firms relative to smaller firms, leading to an increase in concentration.

We also add new insights to recent papers that analyze the distortive impact of tax avoidance. For example, Baugh et al. (2018) show how avoiding sales taxes has allowed online retailers to maintain a price advantage over brick-and-mortar retailers, which has reshaped the U.S. retail industry. Gauss et al. (2022) show that transfer pricing regulations in the E.U. increase the effective taxation of multinationals and foster the profits and sales of domestic firms. Both examples of one industry or one type of avoidance align with our findings that tax avoidance distorts individual sales. We further show that such distortions have contributed to industry concentration across many U.S. industries. Arayavechkit et al. (2018) show that heterogeneity in firms' lobbying for capital-based tax benefits generates capital misallocation.[5] We instead discuss potential misallocation driven by a distortion in sales. A strand of the literature has also focused on the real impact of one specific type of

[4] Cai and Liu (2009) explore the link between competition and tax avoidance using Chinese data. They show that an increase in competition increases tax avoidance.

[5] In a related vein, Kaymak and Schott (2019) examine the capital misallocation induced by loss-offset provisions in the tax code.

tax avoidance, namely profit shifting.[6] Guvenen et al. (2022) show the consequences of tax avoidance on measuring various U.S. macroeconomic indicators. Egger and Wamser (2015), Mooij and Liu (2020), and de Mooij and Liu (2021) also show the adverse impact of anti-profit shifting regulations on firms' investment. Serrato (2018) shows that the repeal of section 936 of the Internal Revenue Code, which prevents U.S. MNEs from shifting profits to affiliates in Puerto Rico, has substantial real effects on the U.S. economy. Souillard (2020b) and Alstadsæter et al. (2022) show that profit shifting impacts wage inequality. Complementary to these papers, we show that tax avoidance affects the distribution of sales in the economy.

Last, we contribute to the literature on tax avoidance and firm size. Several papers in the literature argue that large firms (Gumpert et al., 2016; Davies et al., 2018) or firms with a greater product market power (Kubick et al., 2014) are likely to engage in greater tax avoidance. Our results do not dismiss the idea that large firms are more likely to avoid taxes. Empirically, we account for this by developing an IV strategy to show that causality also goes the other way. More broadly, the counterfactual experiments show that both effects are at work, reinforcing each other. Large firms in many industries have been more likely (or had more incentive) to avoid taxes. Tax avoidance allows them to reinforce their dominant position and increases industry concentration.

2 Theoretical framework

We incorporate tax avoidance in an otherwise standard model to examine how tax avoidance affects firm-level sales and under which conditions it may increase industry concentration.

Model set-up. We consider a simple economy with a distribution of heterogeneous firms that produce horizontally differentiated goods. Firm $i \in [1; N]$ produces $q_i = \varphi_i k_i$ units under constant returns from a single input k_i, for instance, capital or labor available at

[6] On profit shifting by multinational firms see, among many others, Tørsløv et al. (2022), Zucman (2014), Clausing (2016), Clausing (2020b).

a unitary price, and φ_i denotes its productivity. Firms also differ in their ability $\theta_i \geq 1$ to reduce the pre-tax profits declared to tax authorities. As we clarify below, the joint distribution of (φ_i, θ_i) plays no role in the subsequent analysis, so we leave it unspecified.

Denoting the statutory tax rate by t^s, firm i's income taxes are given by $t^s(p_i - \theta_i \varphi_i^{-1})q_i$. In other words, a tax-avoiding firm can increase the production costs used in calculating its income tax liability by a factor $\theta_i > 1$.

After-tax profits of firm i can be written as follows:

$$\pi_i = (1 - t^s) \left(p_i - \frac{1 - t^s \theta_i}{1 - t^s} \varphi_i^{-1} \right) q_i \tag{1}$$

Equation (1) shows that tax avoidance, that is $\theta_i > 1$, gives a competitive edge to a tax-avoiding firm by reducing its effective marginal cost $\frac{1-t^s\theta_i}{1-t^s}\varphi_i^{-1} < \varphi_i^{-1}$. Under standard conditions that guarantee a decreasing marginal revenue as a function of output, this competitive edge implies tax savings are optimally used to sustain more aggressive pricing strategies, which, in turn, boost firms' sales.[7] The increase in sales is achieved by lower costs and prices in our simple framework. Still, it could also be achieved by an increase in the perceived quality of the good in a model in which tax avoidance raises the return to marketing, advertising, or product innovation. This reduced-form modeling of tax planning is consistent with perfectly-legal loopholes. It is also consistent with various profit-shifting techniques as discussed in Appendix A.1.

Demand. We now parametrize firms' profits assuming consumers have CES preferences with an elasticity of substitution $\sigma > 1$. Total expenditure is denoted Y so that demand for the variety supplied by firm i at a price p_i is:

$$d(p_i; \mathcal{P}) = \frac{Y p_i^{-\sigma}}{\mathcal{P}^{1-\sigma}} \,, \tag{2}$$

[7] Such mechanism is in line with evidence in Baugh et al. (2018) that the avoidance of sales tax by online retailers allowed them to maintain a price advantage over brick-and-mortar competitors.

. where $\mathcal{P}$ is the price-index: $\mathcal{P} = \left(\sum_{i=1}^{N} p_i^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$. For most of what follows, we assume firms are price-index takers as in the seminal paper of Spence (1976). Monopolistically-competitive pricing leads to a constant and equal markup for all firms over their effective marginal cost; that is $p_i = \mathcal{M}\frac{1-t^s\theta_i}{1-t^s}\varphi_i{}^{-1}$, where $\mathcal{M}_i = \mathcal{M} = \frac{\sigma}{\sigma-1}$. We relax the assumption of monopolistic competition at the end of this section.

Tax avoidance: From theory to empirics. Our parameter θ_i has no direct counterpart in our dataset, but it can be mapped into observables such as the wedge between the statutory and the effective tax rates (ETRs). The ETR of firm i is given by the ratio of taxes over taxable income, that is, $t_i^e = t^s \frac{(p_i - \theta_i \varphi_i^{-1})q_i}{(p_i - \varphi_i^{-1})q_i}$, so that

$$t^s - t_i^e = t^s \left(\frac{\theta_i - 1}{\mathcal{M}_i \frac{1-t^s\theta_i}{1-t^s} - 1} \right). \tag{3}$$

The above equation shows a more favorable tax position for firm i corresponds to a higher θ_i. Using (2), we obtain sales $s_i(\boldsymbol{\varphi}, \boldsymbol{\theta}) = p(\varphi_i, \theta_i) \cdot d(p(\varphi_i, \theta_i), \mathcal{P}(\boldsymbol{\varphi}, \boldsymbol{\theta}))$ as a function of firm productivity φ_i, tax avoidance ability θ_i and the vectors of firm-level productivity and tax avoidance denoted $\boldsymbol{\varphi}$ and $\boldsymbol{\theta}$, respectively, encapsulated in the price-index. Firm sales s_i then depend on the level of tax avoidance as follows:

$$\begin{aligned} s_i(\boldsymbol{\varphi}, \boldsymbol{\theta}) &= c(\varphi_i)^{1-\sigma} \left(\frac{1 - t^s\theta_i}{1 - t^s} \right)^{1-\sigma} \mathcal{M}^{1-\sigma} \mathcal{P}^{\sigma-1} Y \\ &= z(\varphi_i) \times \tau(\theta_i) \times \kappa(\boldsymbol{\varphi}, \boldsymbol{\theta}). \end{aligned} \tag{4}$$

Firm-level sales thus consist of three (log) separable functions of, respectively, firm-level productivity ($z(\varphi_i)$), firm-level tax-avoidance intensity ($\tau(\theta_i)$), and industry-specific characteristics including the price index ($\kappa(\boldsymbol{\varphi}, \boldsymbol{\theta})$).

From tax avoidance to sales premium. It follows from equation (4) that, under monopolistically competitive pricing, the relative sales of any pair of firms i and j in the industry are given by

$$\frac{s_i(\boldsymbol{\varphi}, \boldsymbol{\theta})}{s_j(\boldsymbol{\varphi}, \boldsymbol{\theta})} = \frac{z(\varphi_i)\tau(\theta_i)}{z(\varphi_j)\tau(\theta_j)}. \tag{5}$$

This expression shows how differences in the intensity of tax avoidance distort relative sales in the economy. When the intensity of tax avoidance is the same across firms ($\tau(\theta_i) = \tau(\theta_j)$ for any pair (i, j)), sales dispersion in the economy is entirely driven by differences in productivity. Instead, an increase in tax aggressiveness by one firm to another leads to an increase in its relative sales. We now examine under which conditions such changes in tax aggressiveness increases concentration.

From micro to macro: concentration and aggregate efficiency. In our quantitative exercise, we use the CR4 – the combined market share of the four largest firms in an industry – as a measure of concentration. If a top 4 firm adopts a more aggressive tax-planning strategy, its market share increases relative to all firms, which leads to an increase in the CR4. If instead, a small firm adopts a more aggressive tax planning strategy, its market share increases relative to all firms, which reduces the CR4 Note that if tax avoidance is facilitated for all firms in a sector, firms' profitability may increase but their relative sales are unaffected.

We show in Appendix A.1 that the intuition is also valid if concentration is measured by the Herfindahl index (HHI) rather than the CR4. Formally, we prove the HHI increases *iff* the firm that increases tax avoidance has a sufficiently large market share ($\mathcal{S}_i > \frac{\mathcal{H}_{-i}}{1+\mathcal{H}_{-i}}$). Last, we investigate the impact of tax avoidance for efficiency, i.e. its impact on real output.

To do so, we show in Appendix A.1 that by linking firm production, firm productivity and CTA, output is given by:

$$\frac{Y}{\mathcal{P}} = \frac{K}{\sum_{i=1}^{i=N} \varphi_i^{-1} \mathcal{S}_i^{\frac{\sigma}{\sigma-1}}} \tag{6}$$

where K is the overall endowment in factor k used by firms. It is maximized when relative market shares reflect relative productivities. Instead, differences in the intensity to avoid taxes distort relative sales, as shown by equation (5). We discuss the implementation of equation (10) in Section 6.

Oligopoly pricing. The closed-form results derived above rest on CES demand and monopolistically competitive pricing assumptions. Accounting instead for oligopoly pricing implies markups are no longer constant across firms: the markup $\mathcal{M}_i$ then becomes an increasing function of a firm's market share, $\mathcal{M}_i = \mathcal{M}(\mathcal{S}_i)$.[8] Indeed, equation (4) still holds, whereas equation (5) becomes

$$\frac{\mathcal{S}_i}{\mathcal{S}_j}\left(\frac{\mathcal{M}(\mathcal{S}_i)}{\mathcal{M}(\mathcal{S}_j)}\right)^{\sigma-1} = \left(\frac{\varphi_i}{\varphi_j}\right)^{\sigma-1}\left(\frac{1-t_s\theta_j}{1-t_s\theta_i}\right)^{\sigma-1}.$$

The above equation implies that, under oligopoly again, a firm's sales increase with tax avoidance.[9] As shown in Appendix A.1, an increase in tax avoidance for the largest firm would increase its relative sales and market shares, increasing concentration as measured by the CR4 or HHI. If instead tax avoidance is facilitated for all firms, market concentration will not be affected. Furthermore, in practice, taking as a dependent variable $\mathcal{S}_i(\mathcal{M}(\mathcal{S}_i))^{\sigma-1}$ or its monopolistic approximation $\approx \mathcal{S}_i\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}$ has virtually no impact on our estimates.

3 Data and facts

The theory predicts a positive impact of tax avoidance on firm-level sales and provides guidance on other factors that influence sales. We use detailed data from Compustat, a database of firm-level financial information from S&P Global Market Intelligence, to construct our variables of interest. The Compustat dataset contains data consolidated at the company level. Our analysis covers 1994-2017 when the U.S. had a worldwide taxation system.

[8] For instance, under Cournot and Bertrand competition, and absent Ford effects, we get $\mathcal{M}(\mathcal{S}_i) = \frac{1}{\rho(1-\mathcal{S}_i)}$ and $\mathcal{M}(\mathcal{S}_i) = \frac{1-\rho\mathcal{S}_i}{\rho(1-\mathcal{S}_i)}$, respectively, where $\rho = \frac{\sigma-1}{\sigma}$.

[9] Note that under oligopoly, the wedge gap given by (3) holds with variable markups i.e. $t^s - t_i^e = t^s\left(\frac{\theta_i - 1}{\mathcal{M}(\mathcal{S}_\rangle)_i \frac{1-t^s\theta_i}{1-t^s} - 1}\right)$. A lower ETR requires a higher θ_i. An interesting implication of (3) is that an increase in tax avoidance implies the direct effect of tax savings on the ETR necessarily offsets the increase in markup.

Our empirical analysis focuses on firms headquartered in the U.S. and excludes subsidiaries. Consistent with prior research, we remove firms in the financial and utilities industries because of their unique regulatory and institutional structures. The unbalanced dataset consists of 14,633 firms in 86 NAICS 3-digit industries. The dataset includes a wealth of financial information such as turnover, employment, domestic and foreign pre-tax income, as well as property, plant and equipment assets, and capital expenditures. The information on intangible assets includes acquired intangibles such as goodwill, blueprints, patents, and software. These variables are key in constructing the set of relevant controls at the firm level that is used in the empirical analysis below. Some of the observations in the dataset are missing, which decreases the size of our estimation sample to 8,925 firms. However, it covers more than 77.5% of total yearly sales, on average, from 1994 to 2017.

3.1 Tax avoidance

Measure of tax avoidance. The literature in accounting and finance uses different measures to analyze tax avoidance. We follow the methodology proposed by Henry and Sansing (2018), which accounts for loss years and allows us to avoid the selection bias when pre-tax income is negative. About 38% of firm-year observations in our sample have negative profits. Restricting our sample to firms with positive income and cash tax paid may thus induce some selection issues. Furthermore, we follow Dyreng et al., 2008; Hanlon and Heitzman, 2010 by measuring tax avoidance over a long period to reduce the volatility found in measures that use annual data and include tax payments of the former period.[10]

The measure developed by Henry and Sansing (2018) tracks the deviation between the actual amount of taxes paid ($TXPD_{is}$) and the amount that would have been paid if the pre-tax financial income (PI_i) were taxed at the statutory rate (τ). Throughout our period of analysis, the profits of a U.S. company were taxed at 35%, regardless of the country where

[10]Because we use data that are consolidated worldwide and smoothed over the long run, we do not observe the tendency of firms to bunch around zero as observed when using unconsolidated data (see, e.g., Koethenbuerger et al., 2019).

they were made. This measure and the use of consolidated data are, therefore, particularly suited to our analysis. We define Henry and Sansing's measure (HS gap) as

$$HS_{is} \equiv \frac{\sum_{t=1}^{S} (CTP_{it} - \tau \times PTI_{it})}{\sum_{t=1}^{S} BVA_{it}} \;, \tag{7}$$

where τ is the statutory tax rate and BVA_{is} is firm's i book value of assets over period s. By computing a measure of the departure of cash tax payments from the statutory tax on book income and scaling by the market value of total assets, the measure avoids the negative-sign problem in ETR when pre-tax income is negative. The book value of total assets is the scalar chosen by Henry and Sansing (2018) and may be arbitrary. It ensures that the HS-gap is defined for both profit and loss observations. BVA_{is} is positive for all observations and facilitates the comparison of the numerator of the HS_{is} variable across firms.

Henry and Sansing (2018) also propose the market value of assets MVA_{is} as an alternative scalar. We show our results are qualitatively similar when scaling with MVA_{is} instead of BVA_{is}, or when using a scale-free (binary) variable that takes the value of 1 when the HS tax gap is negative, and 0 otherwise.

In the regression analysis, we present the results using four-year periods ($S = 4$) to compute our measure of the long-run HS tax gap and check the robustness of our results using a longer period of six or eight years.

A firm without tax preferences will have an HS-gap measure of zero. Firms with a negative HS-gap measure have a favorable tax position. When the firm has a disfavorable tax position, the value of the cash tax paid is larger than the expected tax payment, so HS is positive. Firms are tax-disfavored due to unfavorable permanent and temporary book-tax differences, which may occur when expenses accrued for financial-reporting purposes are deducted for tax purposes on a cash basis or when net operating loss can only be carried forward to offset future income. Firms that conduct aggressive tax-avoidance strategies have a value of cash tax paid that is smaller than the expected tax payment, so HS is negative.

Our concept of tax avoidance is defined broadly as "tax planning activities that are legal, or that may fall into the gray area, as well as activities that are illegal. Thus, tax aggressive activities do not necessarily indicate that the firm has done anything improper" (Chen et al., 2010, pp. 41-42). Therefore, the HS-gap-measures proxies for a whole range of activities that reduce the tax burden. Several accounting papers show the HS-gap measure does capture aggressive tax-planning strategies of companies (see, e.g., Koester et al., 2017).[11] A legitimate concern is that this measure only captures differences in tax credits companies receive for activities such as R&D, and has little to do with tax avoidance. As we show later in section 4.3, our results are robust to controlling for R&D activities.

Tax avoidance in large and other firms. The conjecture regarding the correlation between tax avoidance and concentration rests on the premise that large firms have had more aggressive tax-planning strategies than smaller firms, which has strengthened concentration. Table 1 compares the evolution of tax avoidance of the largest firms and the other firms.

Table 1: Evolution of tax avoidance by firms categories (1994-97, 2014-17)

	LR Effective tax rate (%)			LR HS tax gap		
	1994-97	2014-17	Δ	1994-97	2014-17	Δ
Leaders	29.8	23.8	-6pp	-.004	-.007	-.003
Other firms	30.1	25.5	-4.6.pp	- .0006	.0003	+.0009

Note: *Leaders* is the group of firms that are among the four largest players (in terms of sales) in their 3-digit NAICS industry. *Other firms* are all the other firms in Compustat. Long-run ETR is the sum of cash tax paid over total profits within a group (either *leaders* or *other firms*) and a period (either 1994-1997 or 2014-2017). The long-run HS tax gap is the ratio of the sum of cash tax paid minus .35 times the sum of profits over the sum of total assets computed within a group and a period.

The group of large firms (*leaders*) gathers the top four largest firms within each 3-digit NAICS sector, whereas *other firms* comprises all other firms in Compustat. Tax avoidance is measured by the long-run HS-gap and, as a robustness check, by the long-run ETR, which is

[11]Consistent with the view that the HS indicator capture agressive tax planning, figure A.1 shows multinationals with affiliates in tax havens have a consistently lower HS-gap than other multinationals.

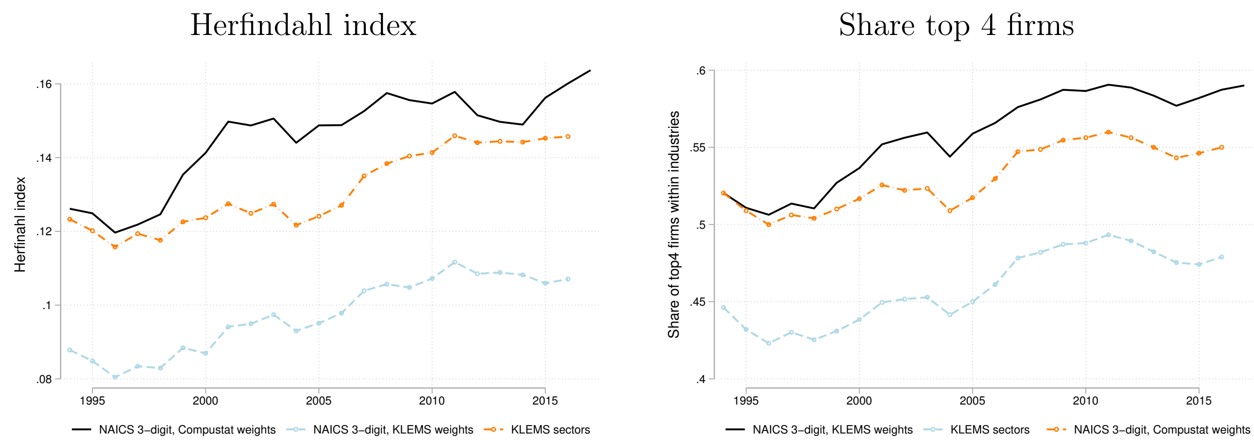
simply the ratio of cash tax paid over profits. Whatever the measure used, tax avoidance has increased from the mid-1990s to the most recent period, consistent with findings in Dyreng et al. (2017). The comparison of figures for *leaders* and *other firms* further reveals the increase in tax avoidance has been more pronounced for the industry leaders. Tax avoidance as measured by the HS tax gap has dropped for large firms but not for smaller ones. The gap between industry leaders and other firms has also increased if one looks at the ETR, which dropped by six percentage points for the industry leaders and 4.6 percentage points for the other firms.

3.2 Industry Concentration

In Figure 2, we examine the evolution of industry concentration using either the Herfindahl index (HHI) or the share of the top four firms in sectoral sales (CR4). We define an industry as a NAICS 3-digit sector and show our descriptive results are robust using the E.U. KLEMS sector classification as an alternative definition of industry. To do so, we create a correspondence between KLEMS and NAICS 3-digit sectors. The aggregate level of concentration is a weighted average of our sector-level measures. The sector weights are computed using Compustat sectoral sales or KLEMS sectoral output data. The left panel of Figure 2 reports the evolution of the average HHI, and the right panel reports the evolution of the share of the top four firms in sectoral sales. The graphs display concentration measures computed with different aggregation schemes. Both panels confirm concentration has increased steadily in the U.S. since the mid-1990s. This observation is in line with evidence reported in Gutiérrez and Philippon (2018) and Grullon et al. (2019), among others.

The documented trends are computed on a sample of U.S. publicly traded firms. Several papers show this subsample of the economy somewhat successfully tracks aggregate trends observed in comprehensive data such as the Census data (see, e.g., Covarrubias et al., 2020).

Figure 2: Evolution of concentration in the U.S. (1994-2017)



Notes: The HHI is computed at the sectoral level and then aggregated. Share top 4 is the share of industry sales made up by the four largest firms. "NAICS 3-digit KLEMS weights": sector-level concentration computed using Compustat data at the NAICS 3-digit industry level and then weighted using KLEMS data. "NAICS 3-digit, Compustat weights": concentration computed using Compustat data at the NAICS 3-digit industry level and then weighted using Compustat sectoral sales. "KLEMS sectors" is a weighted average of HHI computed from Compustat at the level of KLEMS sector.

4 Corporate tax avoidance and sales

4.1 Econometric analysis

Corporate tax avoidance and sales We now turn to the empirical estimation of equation (4). Firm-level sales are determined by the intensity of CTA, factors related to the firm's productivity, and aggregate characteristics at the level of the sector, such as the price index. We estimate a log-linearized version of equation (4) throughout the empirical analysis:

$$\log s_{is} = \beta_0 + \beta_1 \log \tau_{is} + \mathbf{z}'_{is}\beta + \kappa_{k(i)s} + u_{is} \ . \tag{8}$$

The dependent variable refers to the log sales of firm i active in sector $k(i)$ in the last year of period s – or the (log) average sales across years within each period in a robustness check. Our preferred specification takes the sales at the end of the period to limit the simultaneity between sales and tax avoidance. This specification examines past tax avoidance's impact on current sales. We show the results are robust if one considers the average sales over the period rather than the end-of-period sales (See Table OA.7).

Because many firms report negative pre-tax income, we use the measure developed by Henry and Sansing (2018) as a proxy for τ_{is}. Given the definition of the tax-avoidance measure, a finding of $\beta_1 < 0$ would indicate tax avoidance is positively associated with larger sales. Reported tax and profit data may have significant year-to-year variations. We thus follow Dyreng et al. (2008) by smoothing data over several years. The measure thus captures firms' ability to pay a low amount of tax for a long period. We report the results using the four-year period and show they are qualitatively similar when using a longer six or eight-year period.

The vector z_{is} describes factors influencing firm-level productivity. In line with the theory and following the empirical literature, we use the richness of information in the Compustat dataset to construct important controls in our empirical analysis. Some research suggests productivity gains are important drivers of rising sales of large firms. Autor et al. (2020) argue the growth of *superstar* firms has been driven by productivity gains. We approximate the firm's productivity as the ratio of total sales to total employment. We also introduce a measure of intangibles because they are associated with productivity gains according to Crouzet and Eberly (2019). We calculate the intensity of firms in intangible assets as the ratio of intangible assets to total assets. We also include two indicators that have shown to be correlated with firm-level productivity: a dummy variable on acquisitions and payout and a dummy variable that accounts for the firm's multinational status.

The variables $\kappa_{k(i)s}$ are sector-time-specific factors common to all firms within each sector. Our baseline model, therefore, identifies the impact of CTA across firms within a sector. We also use firm fixed effects to control for a broad set of unobserved firm attributes that explain the differences in the levels of sales: the firm's ability to manage tax avoidance, its corporate and managerial practices concerning tax avoidance, and its perception of the legal (tax) environment. u_{iks} is the error term.

Estimating equation (8) by least squares is unlikely to be consistent because large firms are more likely to follow more aggressive tax-planning strategies than smaller firms. Whereas potential reverse causality between size and tax avoidance justifies the use of an instrumentation strategy, the sign and magnitude of the bias of the OLS coefficient are unclear.

Instrumentation strategy. We present the instrumentation variable strategy (IV) used in our baseline analysis. In section 4.3, we present an alternative strategy exploiting the change in the reporting requirement of U.S. publicly listed firms that occurred in 1998. Both strategies lead to qualitatively similar results.

We use the audit probabilities disclosed by the Internal Revenue Service (IRS) to build the instrument for our measure of CTA. Hoopes et al. (2012) show stricter IRS monitoring implies a higher ETR. They further report that 72% of firms assess the probability of being audited when they make tax decisions. We collect data from the IRS annual Data Books, which disclose relevant information for eight asset classes across years. We construct the audit probability as the number of corporate tax return audits completed in the IRS's fiscal year t for an IRS asset-size group divided by the number of corporate tax returns received in the previous calendar year for the same IRS asset-size group upward.

These probabilities are correlated with firm size because the IRS has a higher audit rate for larger companies. We compute a measure of audit probability that is orthogonal to size- and year-specific patterns. The residual audit probabilities, $Audit^{adj}_{g(i)t}$, are constructed using the residuals of a regression of disclosed probabilities on asset class and year fixed-effects. Therefore, the mechanical correlation between the raw audit probability and firm size is broken.

The residual of the audit-probability regression captures the yearly fluctuations in audit probability specific to each asset class due to the inclusion of year-fixed effects in the regression. We visualize the audit probabilities by a class of assets over the sample period in Figure A.2 of Appendix A.2. The residual audit probabilities are not correlated with the asset class, preventing any mechanical correlation between our IV and firm size. A high residual audit probability for an asset class in a given year means that, within this year, firms in this asset class are relatively more likely to be audited. In other words, the related expected cost of avoiding taxes for firms in this asset class increases, which should shift their level of tax avoidance.

Whereas adjusted audit probability is specific to a year and an asset class, our instrument is specific to a firm and a period. We take for each firm in each year its corresponding residual audit probability that we average over four years in our baseline estimation – or six or eight years in a robustness check. The instrument varies across firms and periods because the assigned residuals may change within a period as firms change the asset class. The instrument is given by:

$$Audit_{is}^{adj} = \sum_{t \in s} Audit_{g(i)t}^{adj} / N^S,$$

where $Audit_{g(i)t}^{adj}$ is the adjusted audit probability of firms in asset-size class g and N^S is the number of years t in period s. The within-sector and period correlation between our instrument and the raw audit probabilities is low at about 19%.

Our identification strategy rests on the assumptions that tax avoidance at the level of firms responds to changes in the audit rates and that firm sales at the end of each period do not affect the average changes in audit probabilities across years within each period. The first assumption is likely to hold. The literature on tax enforcement predicts that all else equal, a decrease in tax enforcement increases tax avoidance (Hoopes et al., 2012; Nessa et al., 2020). Different elements suggest the second assumption is also verified. Anecdotal evidence and more in-depth analysis in the accounting literature suggest that changes in audit probability are explained by the underfunding of the IRS. For instance, Nessa et al. (2020) show that IRS resources positively correlate with audit probability and the net revenue collected through tax enforcement. The reduction of the IRS enforcement budget resulted from Congress warfare between Democrats and Republicans. As Kiel and Eisinger (2018) report, the Republican-controlled Senate in 1997 and 1998 held a series of dramatic hearings on alleged abuses by the IRS.[12] Hoopes et al. (2012) argue this drop is tightly linked to cuts in the budget of the IRS. It is thus likely exogenous to individual companies' decisions concerning tax planning. Importantly, the tax-avoidance behavior of large firms lobbying on taxation issues was not the main motivation for cuts in the funding of the IRS. As we show in section 4.3, a firm's participation in lobbying on taxation or internal revenue code does not influence the effects of the residual audit probability on the level of CTA. Lobbyists have larger sales, but controlling the lobbying status of firms does not affect the impacts of tax avoidance on sales.

4.2 Baseline results

Table 2 shows the OLS and 2SLS regressions results. We include a set of sector- and period-specific effects to control for unobserved characteristics in each specification. We, therefore, identify the effect of each covariate using the variation in firm-level attributes across firms within sectors and periods. We also include firm fixed effects in some specifications. In this case, we use the variation of firm-level characteristics within the firm to identify the effect of tax avoidance and other covariates. We report robust standard errors in all specifications.[13]

In column (1), we report the OLS results, including sector and period fixed effects. We find a negative impact of the HS_{is} measure on firm-level sales, which suggests a positive impact of tax avoidance on sales. This effect is significant at the 99% confidence level. The other covariates have the expected signs and are highly significant at conventional levels. Firms with a larger share of intangibles and higher workforce productivity have larger sales.

[12] A more recent reason for cutting the IRS funding is that the agency was chosen to monitor the Affordable Care Act. Instead, there were no cuts during the George W. Bush administration, and tax collection increased over this period (and the audit probability of large firms remained flat), which political commentators explain by the fact that the IRS was not an object of a dispute during this era.

[13] The sampling and assignment mechanisms are not clustered in our setting. We thus follow Abadie et al. (2023), who argue that "if the sampling and assignment mechanisms are not clustered, one should not adjust the standard errors for clustering, irrespective of whether such an adjustment would change the standard errors." The results hold if standard errors are clustered at the level of the firm, as shown in the online Appendix OA.1 (Table OA.1).

Table 2: Sales and tax avoidance – OLS and 2SLS estimates

Dep. Variable	Log Sales - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.648***	-1.038***		-4.916***		-4.922***
	(0.125)	(0.118)		(0.491)		(1.438)
Share of Intangible	1.167***	1.144***	-0.030***	1.064***	-0.070***	0.845***
	(0.082)	(0.076)	(0.011)	(0.088)	(0.019)	(0.156)
Labor Prod.	0.524***	0.484***	-0.054***	0.396***	-0.046***	0.307***
	(0.017)	(0.032)	(0.003)	(0.030)	(0.005)	(0.073)
Acquisition	1.243***	0.253***	-0.037***	1.150***	-0.006*	0.231***
	(0.029)	(0.017)	(0.004)	(0.034)	(0.003)	(0.022)
MNE Status	1.478***	0.317***	-0.071***	1.314***	-0.015***	0.263***
	(0.028)	(0.025)	(0.004)	(0.042)	(0.004)	(0.032)
Audit Prob. (Adj.)			0.013***		0.003***	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	22,271	18,546	22,271	22,271	18,546	18,546
Adj. R^2	0.527	0.930	0.143		0.610	
KP F-stat.				124.6		11.62

Sample years: 1994-2017. The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First-stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

These findings support the results of Crouzet and Eberly (2019) and Autor et al. (2020) that industry leaders are often very good at producing intangible assets and are highly productive. In line with the literature that looks at the performance of multinational firms, we find these firms have larger sales than purely domestic firms (Antràs and Yeaple, 2014). The acquisition dummy variable is also positive and highly significant. These results are robust to including firm-fixed effects in column (2).

In columns (3) and (4), we report the results of the 2SLS estimations using sector and period fixed effects. Column (3) reports the first-stage results. We find a positive and highly significant impact of the residual audit probabilities on the HS gap. This result is in line with Hoopes et al. (2012) and Nessa et al. (2020), which show U.S. firms undertake less aggressive tax positions when tax enforcement is stricter. This finding suggests our tax avoidance measure captures more than legal tax breaks.

As noted previously, the specification that includes sector and period fixed effects uses the variation in the IRS's audit probabilities across firms within sector and period. This finding suggests the heterogeneous cuts in the IRS's audit probabilities have contributed to tax avoidance across firms within sectors and periods.

In column (4), we report the second-stage results and show the causal impact of tax avoidance on firm-level sales. The coefficient of the HS_{is} measure is negative and highly significant. Decreasing the firm's HS gap from the 90^{th} to the 10^{th} percentile increases the firm's sales by about 0.7% on average.

In columns (5) and (6), we estimate the 2SLS model by adding firm-specific effects. We still find that reducing the IRS audit probability significantly increases firm-level tax avoidance. Column (6) confirms tax avoidance's causal and positive impact on firm-level sales. The effect is similar in magnitude to the one in column (4).

In both specifications, the large value of the Kleibergen-Paap F-statistic (KP F-stat) confirms the strength of our instrument. The statistics yield values larger than 10 in the model that uses sector×period-specific effects and those that include firm-specific effects. These findings suggest the regression estimator is unlikely to suffer from weak-instruments bias.

4.3 Robustness of the results

The finding that CTA has a causal impact on sales is key to our analysis. In this section, we show this result is robust to the introduction of various controls, changes in the construction of our main variables of interest, and using an alternative identification strategy. The main findings of this robustness analysis are summarized below, with a comprehensive exposition of the details and tables presented in the Online Appendix (Tables OA.2 to OA.13).

Lobbying activities and R&D. We first conduct a thorough investigation to ensure that our results are not subject to any potential bias from confounding factors such as tax lobbying activity of firms and R&D expenditures.

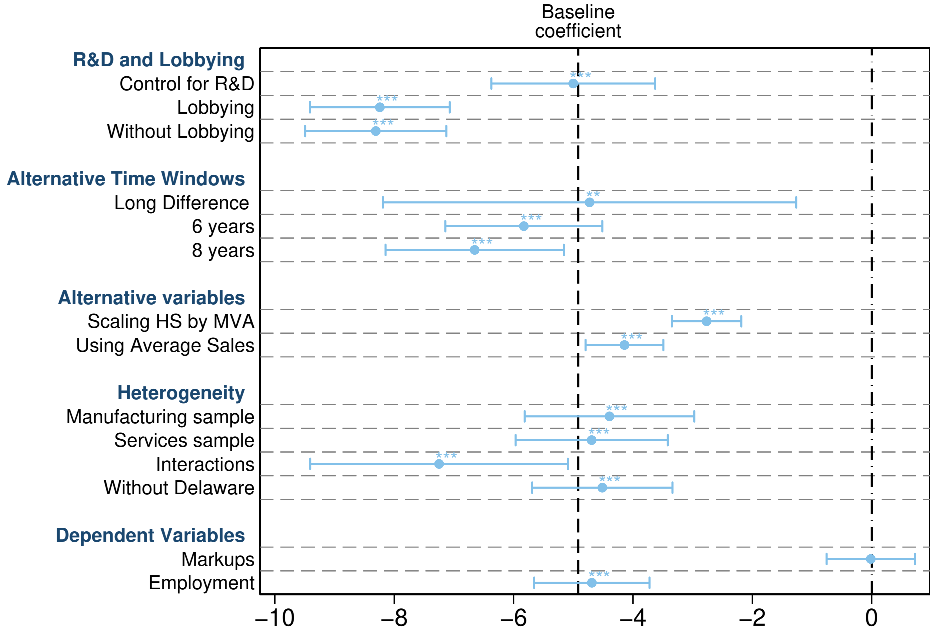
It is legitimate to ask whether heterogeneity in our tax avoidance measure reflects differences in R&D tax credits, which would lead to a different interpretation of our findings. An increase in R&D may spur sales and allow firms to save on taxes. Information on R&D expenditures is missing for about 40% of the firms and observations in our baseline sample. We show the positive impact of tax avoidance on sales is robust to the inclusion of R&D expenditures in this restricted sample. We lag the R&D variable by five periods because the effects of R&D on firm-level sales may not be contemporaneous.[14]

Arayavechkit et al. (2018) show the firm size and effective tax rate are positively correlated with their lobbying activities. We use data on lobbying activities of U.S. firms from Kim (2018) to create an indicator that provides information on the firm's participation in lobbying on taxation or the internal revenue code. Firms that engage in lobbying on taxation issues are larger than non-lobbying firms, but this variable does not affect the causal effect of CTA on sales. Lobbying has no impact on the level of CTA, and including the lobbying dummy variable does not affect the effects of residual audit probability on aggressive tax-planning strategies. To mitigate the influence of lobbying activities, we estimate the effect of tax avoidance on sales in a sample of firms that do not engage in lobbying activities. The causal effect of tax avoidance on sales persists.

Other sensitivity analysis. We conduct additional tests to assess the causal relationship between tax avoidance and sales and summarize our key findings below. Figure 3 presents the second-stage coefficients of the HS tax gap in various regression models used for our sensitivity analysis. Further details and relevant tables are included in the Online Appendix.

First, we investigate whether our results are sensitive to the length of the time window

[14] Using contemporaneous R&D expenses does not change the main results: an increase in tax avoidance positively affects sales. The coefficient of the contemporaneous R&D variable is, however, not significant.



Notes: The baseline coefficient is taken from Table 2 and is the semi-elasticity of the HS tax gap in the regression that includes sector and period FE (coef=-4.916, s.e.=0.491).

Figure 3: Sensitivity analysis

used for identification. Our results hold when using a six- or eight-year window. However, the effects become statistically insignificant when we include firm-fixed effects, which is expected given the smaller number of periods used for identification. Moreover, the results using a long difference in a sample of firms with positive sales in both the first and the last period of our sample confirm our findings on the causal impact of tax avoidance on sales. Additionally, using the average sales within a time window rather than the sales at the end of the period as an explanatory variable does not affect the results.

Second, we test our results' sensitivity to the HS measure. Similar results are obtained when using the market value of assets instead of the book value to scale the measure. Using an indicator variable, we also create a scale-free measure of avoidance and find that tax-avoiding firms have larger sales. Additionally, using the average sales within a time window rather than the sales at the end of the period as an explanatory variable does not affect the results.

Third, we investigate the heterogeneity in the impact of tax avoidance on sales across sectors and firms. We find that the positive impact is pervasive in manufacturing and services industries and is magnified for high-productivity firms and those that increased their share of intangible assets. Furthermore, we show that our results are not driven by firms incorporated in Delaware.

Fourth, we test the impact of tax avoidance on firm-level markups and find no significant effect, consistent with our baseline model under monopolistic competition and CES preferences. Finally, we show that tax avoidance positively and significantly impacts firm-level employment. Our results suggest that tax avoidance can increase employment by reducing effective marginal costs and increasing output.

Alternative identification strategies. We now show the robustness of the causal impact of tax avoidance on sales to an alternative identification strategy that exploits changes in how multinationals could report their earnings. We focus on two events that eased U.S. multinationals' avoidance: the check-the-box (CTB) regulations enacted in 1997 and the SFAS-131 enacted in December 1998. Under CTB regulations, U.S. firms can choose whether foreign subsidiaries should be treated as foreign corporations or disregarded as foreign entities of another corporation. In the latter case, payments between the disregarded foreign entities and other controlled foreign corporations of a U.S. firm are disregarded for U.S. tax purposes. SFAS 131 breaks the mandatory requirement to disclose geographic earnings by the jurisdiction in financial reporting. Both regulations have been shown to facilitate the avoidance of treated firms (Blouin and Krull, 2014; Congress, 2010; Sullivan, 2004; Hope et al., 2013; Herrmann and Thomas, 2000)

We compare the outcomes of multinationals relative to domestic firms during the 1993-1996 period before these two regulations were enacted with their outcomes during the 1999-2004 post-treatment period when both regulations were enacted.[15] More specifically, we use this experiment in two ways. First, we estimate a standard difference-in-differences

[15] In the online appendix, we also show that the results hold if we use 1997-2004 as the post-treatment period.

equation in which sales are regressed on an indicator of the MNE status of the firm and its interaction with a dummy variable, which takes the value of 1 in the period post-treatment. We expect the interaction term to positively impact sales because the SFAS-131 and the CTB regulations help multinationals avoid taxes. The coefficient of the *Post* variable cannot be identified because it is perfectly collinear with the sector and year fixed effect. Second, we use the interaction term as an instrument for tax avoidance in the 2SLS specification.

Table 3 presents the results of our alternative strategy using both difference-in-differences and 2SLS estimations. The difference-in-differences strategy compares the sales of multinational firms (the treated group) with domestic firms (the control group), before and after the introduction of laxer regulations. The interaction between our treatment variable and the post-reform dummy is positive and significant, which means firms that benefited from the change in legislation experience increased sales. This finding holds when we use firm fixed effects.

The first stages of the 2SLS regressions use the HS-gap measure of tax avoidance as a dependent variable. Whatever the set of fixed effects included in the regressions is, we find negative and significant interaction coefficients, which confirms that multinational firms significantly increased their level of tax avoidance after 1998. The second-stage results show a negative and significant impact of the instrumented tax avoidance measure on sales. These results confirm the causal impact of tax avoidance on sales.

Table 3: Sales and tax avoidance – quasi-experiment

Dep. Variable	Log Sales - End of Period					
	Diff-in-Diff	2SLS		Diff-in-Diff	2SLS	
		1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	
HS tax gap			-4.910***			-9.251**
			(0.902)			(3.591)
Share of Intangible	1.568***	-0.030**	1.420***	1.610***	-0.034	1.300***
	(0.137)	(0.014)	(0.132)	(0.206)	(0.028)	(0.311)
Labor Prod.	0.963***	-0.065***	0.644***	0.668***	-0.037***	0.330**
	(0.027)	(0.004)	(0.063)	(0.059)	(0.008)	(0.160)
Acquisition	1.069***	-0.022***	0.963***	0.303***	-0.009***	0.220***
	(0.039)	(0.004)	(0.042)	(0.037)	(0.003)	(0.055)
MNE Status	1.313***	-0.008***	1.276***			
	(0.051)	(0.002)	(0.053)			
MNE × $Post_{1998}$	0.386***	-0.079***		0.134***	-0.014***	
	(0.073)	(0.007)		(0.046)	(0.004)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes
Obs.	11051	11051	11051	6178	6178	6178
Adj. R^2	0.468	0.184		0.889	0.358	
KP F-stat.			117			11.41

The dependent variable is the firm's log sales at the end of the six-year window. We have two periods of analysis starting in 1993. OLS and 2SLS estimates with robust standard errors in parentheses. First-stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

5 Impact of tax avoidance on concentration

Having established the causal effect of tax avoidance on sales, we explore its consequences for industry concentration. We build on the insights of our theoretical model and use the estimated semi-elasticity of CTA firms' sales (Table 2, column 6) to assess the quantitative impact of tax avoidance on the distribution of sales. To do so, we compute the counterfactual level of industry concentration in 1994 if firms resorted to their CTA strategy of 2017. This experiment is a way to single out the contribution of CTA to the 1994-2017 change in industry concentration.

Firm i's counterfactual level of sales can be written as $\hat{s}_i = z(\varphi_i) \times \tau(\hat{\theta}_i) \times \hat{\kappa}$. Using the expression of $z(\varphi_i)$ from equation (4), firm i's counterfactual sales and its market share are a function of observed sales and change in CTA:

$$
\begin{aligned}
\hat{s}_i &= \frac{\tau(\hat{\theta}_i)}{\tau(\theta_i)} \times \frac{\hat{\kappa}}{\kappa} \times s_i \\
\Leftrightarrow \frac{\hat{s}_i}{\sum_j \hat{s}_j} &= \frac{\tau(\hat{\theta}_i)/\tau(\theta_i) \times s_i}{\sum_j \tau(\hat{\theta}_j)/\tau(\theta_j) \times s_j}.
\end{aligned} \tag{9}
$$

Note the counterfactual market share of firm i in equation (9) - unlike the counterfactual level of sales - does not depend on the counterfactual price index. It only depends on (observed) individual sales s_i, and the impact of a change in tax avoidance of sales $\tau(\hat{\theta}_i)/\tau(\theta_i)$, which is back-out from the observed changed in tax avoidance and the sensitivity of tax avoidance to sales estimated in Table 2.

We do not observe the level of avoidance of each firm in 1994 and 2017 because of attrition. To address this challenge, we consider the sales of the four largest firms in each industry in 1994 and the level of tax avoidance of the top 4 in 1994 and 2017. We use expression (9) to compute the counterfactual levels of CR4 (the combined market share of the top largest firms within an industry) across U.S. industries:

$$
\widehat{CR4} = E(CR4_{1994} | HS = HS^{2017}, \varphi^{1994}) .
$$

The deviation of the counterfactual from the observed CR4 in 1994: $\Delta_c = \widehat{CR4} - CR4_{1994}$ allows us to answer our question. Δ_c provides information on the change in concentration measured by the CR4 in 1994 had firms followed their CTA strategy of 2017. Besides Δ_c, we also report in Table 4 the observed concentration ratios and their evolutions between 1994 and 2017, Δ_o . We also build ratios of counterfactual changes to observed changes in CR4: Δ_c/Δ_o ($\Delta_o = CR4_{2017} - CR4_{1994}$).

The average counterfactual CR4 change is about 0.3 percentage points (p.p.), whereas the observed CR4 change is about five p.p. These figures imply that, for the average industry, about 6% of the increase in concentration can be explained by the relative rise of tax avoidance by the four largest firms. This average, however, masks substantial heterogeneity

Table 4: Evolution of observed and counterfactual industry concentration.

NAICS	Indus. weight	Observed $CR4_{17}$	Observed $CR4_{94}$	$\widehat{CR4}$	Δ_o	Δ_c	Δ_c/Δ_o
325 Chemical Manuf.	0.074	0.339	0.311	0.319	0.027	0.008	0.296
446 Health and Personal Care Stores	0.023	0.959	0.768	0.799	0.191	0.031	0.162
454 Nonstore Retailers	0.010	0.883	0.500	0.546	0.382	0.046	0.120
334 Computer and Electronic Prod. Manuf.	0.081	0.434	0.284	0.299	0.150	0.015	0.100
481 Air Transportation	0.013	0.835	0.783	0.788	0.051	0.005	0.098
517 Telecommunications	0.033	0.906	0.790	0.798	0.116	0.008	0.069
452 General Merchandise Stores	0.074	0.862	0.624	0.638	0.238	0.014	0.059
311 Food Manuf.	0.038	0.533	0.362	0.368	0.171	0.006	0.035
448 Cloth. and Accessories Stores	0.013	0.502	0.467	0.468	0.035	0.001	0.029
424 Merchant Whole., Nondurable Goods	0.046	0.651	0.532	0.535	0.120	0.004	0.033
322 Paper Manuf.	0.021	0.675	0.452	0.456	0.223	0.004	0.018
312 Beverage and Tobacco Prod. Manuf.	0.023	0.833	0.859	0.851	-0.027	-0.009	0.333
515 Broadcasting (except Internet)	0.020	0.653	0.678	0.673	-0.025	-0.005	0.200
336 Transportation Equipment Manuf.	0.100	0.584	0.674	0.671	-0.091	-0.003	0.033
211 Oil and Gas Extraction	0.017	0.390	0.584	0.580	-0.193	-0.004	0.021
519 Other Information Serv.	0.021	0.750	0.978	0.980	-0.229	0.002	-0.009
445 Food and Beverage Stores	0.025	0.924	0.481	0.478	0.443	-0.003	-0.007
324 Petroleum and Coal Prod. Manuf.	0.074	0.783	0.696	0.694	0.087	-0.001	-0.011
722 Food Serv. and Drinking Places	0.011	0.593	0.494	0.492	0.099	-0.002	-0.020
331 Primary Metal Manuf.	0.013	0.533	0.272	0.264	0.261	-0.008	-0.031
423 Merchant Wholesalers, Durable Goods	0.022	0.287	0.312	0.313	-0.025	0.001	-0.040
333 Machinery Manuf.	0.030	0.418	0.322	0.317	0.096	-0.005	-0.052
511 Publishing Industries (except Internet)	0.018	0.646	0.298	0.280	0.348	-0.018	-0.052
541 Prof., Scientific, and Tech. Serv.	0.020	0.296	0.430	0.455	-0.133	0.026	-0.195
332 Fabricated Metal Prod. Manuf.	0.010	0.412	0.425	0.429	-0.013	0.004	-0.208
561 Admin. and Support Serv.	0.010	0.359	0.339	0.331	0.020	-0.008	-0.400

Notes: Results for industries consisting of more than eight firms and whose weight in the U.S. economy is larger than or equal to 1%. Industry weights are the average of the weights in 1994 and 2017.

across sectors.[16]

We classify the sectors into three categories. In the first category, increases in large firms' tax avoidance pushed industry concentration upward, and concentration indeed increased over the last two decades. Industries in this category are among the largest industries in our sample, jointly accounting for almost 51% of aggregate sales.

[16]For the sake of space, we display the results for industries composed of more than eight firms whose weight in the U.S. economy is larger than or equal to 1%.

The role of tax avoidance in shaping large U.S. industries is consistent with a body of evidence. Concentration among nonstore retailers has been driven by Amazon, whose tax-avoidance practices explain part of its competitive advantage. Baugh et al. (2018) show the sales-tax avoidance of nonstore retailers gave them an advantage over brick-and-mortar retailers. A similar mechanism is likely at work within the nonstore retail sector for firms that managed to use their worldwide online presence to avoid corporate taxes.

The link between tax avoidance and concentration is also consistent with anecdotal evidence in the chemical industry. In the early 2000s, big pharmaceutical companies had difficulties replacing blockbuster drugs and built their growth on external acquisitions. According to Sullivan (2013), tax avoidance was an important strategy to raise money to acquire firms.[17]

Of course, tax avoidance is not the only ingredient that contributes to concentration in these industries. The aggressive tax planning of Apple or Amazon is likely to have been detrimental to their competitors, but these companies' growth is also the result of breaking innovation. Consistent with this view, the ratios of predicted versus observed change in the CR4 for these industries range from 2% to almost 30%, which shows tax avoidance is an important but not the main determinant of industry concentration.

In the second category, which accounts for about 18% of aggregate sales, large firms' relative decline in CTA pushed concentration down, and observed concentration decreased as well. This pattern is observed in the industry of transportation equipment, which is the largest of that category.

In the third category of industries, CTA pushes concentration in a direction, but other forces counterbalance the tax-avoidance effects. For instance, in the industry of petroleum and coal products manufacturing, which accounts for about 7% of U.S sales, observed concentration has increased, whereas the counterfactual CR4 has decreased. The sector of food and beverage stores is another example of an industry in which tax avoidance seems to have

[17] Pfizer, for instance, repatriated $37 billion after the 2004 repatriation holiday and uses this cash to buy Wyeth (Sullivan, 2013).

played no role in the huge increase in concentration. The absence of tax avoidance is not surprising in such a sector where both large and small firms operate in the U.S., which limits their ability to avoid taxes.

6 Extension: the macroeconomic cost of tax avoidance

We show in this extension that CTA-induced distortions in firm-level sales are large enough to influence real production in many industries significantly. The model used through the analysis draws a link between production, firms' productivity, and CTA, leading to equation (10). Tax avoidance, however, is only one of the many sources of sales distortion in the economy. Thus, we adjust equation (10) as follows:

$$\frac{Y}{\mathcal{P}} = \frac{K}{\sum_{i=1}^{i=N} \widetilde{\varphi}_i^{-1} \mathcal{S}_i^{\frac{\sigma}{\sigma-1}}} \tag{10}$$

where the existence of other distortions imply that $\widetilde{\varphi}_i \neq \varphi_i$. The initial gap between $\widetilde{\varphi}_i$ and φ_i imply that tax avoidance reduction can decrease or increase real output. Concretely, large firms in 1994 might have been producing more than what would be predicted by their productivities φ_i. In this case, tax avoidance by large firms would increase distortions and thus decrease output by allocating more market shares to large firms. Alternatively, large firms in 1994 could produce relatively less than predicted by their relative productivity. In this case, tax avoidance by large firms would decrease distortions, and real output would increase.

In the quantitative exercise below, we remain agnostic about the type and magnitude of non-tax distortions at play. We derive the upper and lower bounds of real-output change implied by CTA changes between 1994 and 2017. Whether tax avoidance has the potential to affect real output can be directly observed by the wedge between the upper and lower bounds. If CTA does not play a role, the wedge should equal zero. In each sector, we consider two representative firms. The variable $\mathcal{S}$ denotes the market share of the four largest firms, and $1-\mathcal{S}$ aggregates the market shares of all other firms. By construction, the upper bound is larger than 1, and the lower bound is lower than 1. It reflects the ambiguous impact of CTA on real production depending on other distortions as described above.

We show in Appendix A.1 that the change in real production belongs to the following interval:

$$\widehat{\left(\frac{Y}{P}\right)} \in \left[\min\left\{\left(\frac{\mathcal{S}'}{\mathcal{S}}\right)^{\frac{\sigma}{\sigma-1}}, \left(\frac{1-\mathcal{S}'}{1-\mathcal{S}}\right)^{\frac{\sigma}{\sigma-1}}\right\}; \max\left\{\left(\frac{\mathcal{S}'}{\mathcal{S}}\right)^{\frac{\sigma}{\sigma-1}}, \left(\frac{1-\mathcal{S}'}{1-\mathcal{S}}\right)^{\frac{\sigma}{\sigma-1}}\right\}\right]. \tag{11}$$

$\mathcal{S}'$ denotes the counterfactual market shares of the four largest firms in 1994 as if they had a tax-avoidance level of 2017. Y' and $\mathcal{P}'$ are the counterfactual values of sector-level output and price index, respectively. These bounds are conservative intervals of the impact of tax avoidance as we abstract from inter-industry linkages.

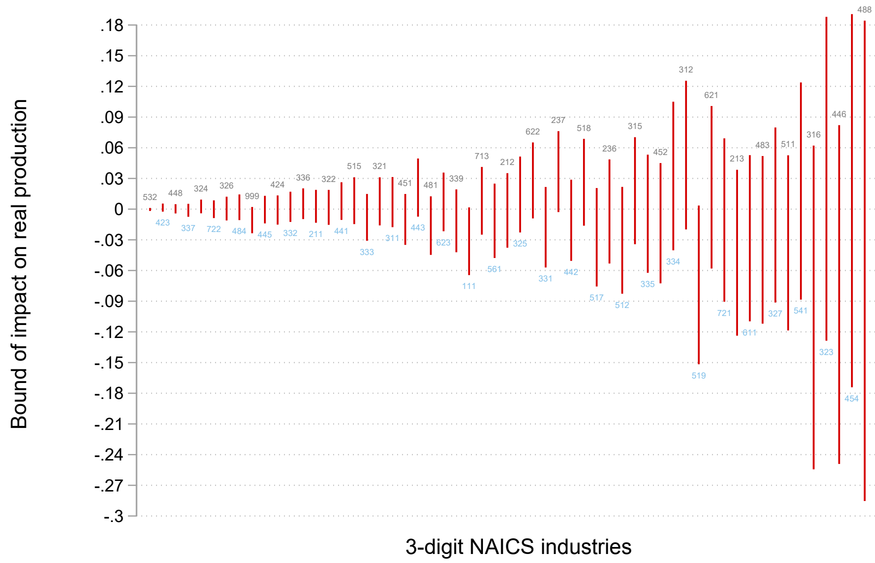
We use equation (11) to compute the upper and lower bounds for each industry by assuming a value of σ to be equal to 2. For the average industry, the CTA-induced change in the CR4 index is consistent with a movement in real production ranging from a drop of 6% to an increase of 5%. Note the results remain quantitatively important, assuming a larger elasticity σ equal to 4. In this event, the upper and lower bounds of production changes are 3% and -4%, respectively.

Determining the sign and exact magnitude of these changes would require an estimation of all other frictions in the economy, which is beyond the scope of this paper.

The upper and lower bounds for each sector are reported in Figure 4. We see that in many industries, the change in the CR4 induced by the change in tax avoidance of large versus small firms might be consistent with large swings in real production.

The changes in market shares induced by CTA could have quantitatively important effects on production in many industries. Such industries include chemical manufacturing, electronic products, or non-store retailers, in which CTA has been shown to play a significant role in the increase in concentration. Real production in these industries could move between -2% and 5%, -4% and 10%, and -18% and 18%, respectively. In other industries, CTA has a small impact on real production, such as in the transportation equipment manufacturing

Figure 4: Bound of CTA impact on real production



Notes: each dash represents the upper and lower bound of the impact of CTA on real production. The 3-digit code of each sectors is reported at the end of the dash. Bounds are computed using formula in eq 11, calibrating $\sigma = 2$. Reading: for NAICS sector 212, the change in CTA could change real production from -3% to 3%.

industry, where the CTA effect on real production ranges from -0.5% to 0.7%. As shown earlier, this industry experienced a decrease in concentration, as did the petroleum and coal production manufacturing, in which concentration increased, but the CTA of large firms decreased relative to small firms. In this industry, the CTA effect on real production ranges from -1% and 2%.

To sum up, our results show changes in CR4 induced by tax avoidance may have non-negligible impacts on real production. Furthermore, note we have abstracted from sectoral linkages that would only magnify the impact on real output.[18] Policy-wise, we conclude that, beyond the increase in corporate tax revenue, curbing tax avoidance can induce a substantial change in allocative efficiency.

[18]For instance, if sectors are aggregated in a Cobb-Douglas fashion, the presence of distortions in a single sector affects the rest of the economy.

7 Conclusion

In this study, we provide compelling evidence of the causal relationship between tax avoidance and firm-level sales. We demonstrate that tax avoidance has given a competitive edge to firms that engage in it. Our analysis shows that large corporations' relative increase in tax avoidance has contributed significantly to the observed increase in industry concentration since the 1990s. In specific sectors, such as chemical manufacturing, non-store retailers, or computer products, tax avoidance by large firms could explain up to 30% of the industry concentration increase. We also find that tax avoidance can distort market shares and influence real production in many industries beyond its impact on government revenues.

Our results have important implications for tax and competition policy, and our findings highlight the interdependence of these policies. We demonstrate that the enforcement of corporate tax policy can help curb industry concentration and that laxer tax enforcement has favored larger firms in the US since 1990. The European Commission's rulings against tax breaks given to Apple, Fiat, Amazon, and Starbucks further underscore the need for coordinated tax policies to ensure fair competition within the European Union.[19]

Our study has broad implications for any reform of international taxation that changes the relative tax position of small and large firms, as such reforms could significantly impact firms' sales distribution and, thereby, real output. Our findings suggest that tax policy should be an integral part of competition policy and that policymakers must work towards coordinated tax policies to ensure a level playing field for all firms.

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[19] According to Commissioner Margrethe Vestager, "We have to continue to use all tools at our disposal to ensure companies pay their fair share of tax (· · ·) If Member States give certain multinational companies tax advantages not available to their rivals, this harms fair competition in the European Union in breach of state aid rules." (The European Commission, 2020).

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A Appendix

A.1 Theory

A.1.1 Micro-founding tax avoidance

Our reduced-form modeling of tax planning is consistent with perfectly-legal loopholes or even fiscal incentives designed to encourage investment. It also aligns with various profit-shifting techniques across affiliates in different jurisdictions. While the exact channel through which firms reduce their tax burden is not relevant per se, it should be noted that our instrument strategy captures practices whose legality is at least debatable, e.g., profit-shifting techniques through transfer pricing. Generally, a tax-avoiding firm may manipulate the value of intra-firm transactions (transfer pricing) to shift their tax base to low-tax jurisdictions.[20]

We detail three cases below. A profit-shifting firm may i) inflate costs by importing from an affiliate located in a low or zero tax jurisdiction a good or service beyond its "arm's length" ii) borrow from an affiliate in a tax haven, and deduct interest payments in the non-haven country while declaring them in a tax haven where they are not taxed iii) locate their intangible assets (e.g., intellectual property) in tax havens.

[20] Note that low and high tax jurisdictions may coexist in one country: the discussion below does not imply that the bulk of tax avoidance is international rather than domestic.

Transfer pricing. A common practice that firms adopt to shift profits to a low-tax jurisdiction is to inflate the costs of inputs (p^I) sourced from their affiliates in tax havens. Without loss of generality, we can assume taxes are almost nil in tax havens; that is, $t^H \approx 0$, and inputs are produced at almost no cost. Firm profits then read:

$$\pi_i = (1-t^s)\left(p_i - p^I - \varphi_i^{-1}\right) q_i(p_i) + p^I q_i(p_i)(1-t^H) . \tag{12}$$

Simplifying, we get

$$\pi_i = \left(p_i - \varphi_i^{-1}\right) q_i(p_i) - t^s \left(p_i - \varphi_i^{-1}\theta_i\right) q_i(p_i) , \tag{13}$$

where $\theta_i = 1 + \varphi_i p^I$.

If the profit-maximizing transfer price results from a trade-off between a lower effective tax rate and a concealment cost, θ can be endogeneized as in Davies et al. (2018). When large firms benefit from scale economies in their tax planning, $\theta(\varphi)$ increases with firm productivity, so large firms deviate more from the arm's-length price than small firms. A similar argument can be made if firms instead manipulate their export prices to foreign affiliates in tax havens downward.

Debt shifting In the spirit of Mintz and Smart (2004), capital is the sole factor of production. Technology is linear, and capital productivity is equal to φ. One affiliate in a tax haven may lend for free to the parent firm in a non-haven. We assume no outside debt can be issued so that the deduction in the non-haven corresponds exactly to the interest payments declared in the tax haven. We denote $b_i > 0$, the per-unit interest payment of capital in the non-haven country. Overall, the firm uses q_i/φ_i units of capital so that total interest payments amount to $b_i\varphi_i^{-1}\varphi_i^{-1}q_i$. Firms' profits are then given by:

$$\pi_i = (1-t^s)\left(p_i - \varphi_i^{-1}\right) q_i + t^s b_i \varphi_i^{-1} q_i - t^H b_i \varphi_i^{-1} q_i , \tag{14}$$

where t^H is the corporate tax rate in the tax haven. This leads back to our baseline equation with $\theta_i = \frac{t^s - t^H}{t^s} b_i$. In the absence of taxation in the tax haven, that is, $t^H = 0$, θ_i comes down to the per-unit interest payment b_i. As in Mintz and Smart (2004), b_i may be endogeneized, assuming borrowing is costly. In that case, firm size and profit shifting would be co-determined by φ_i.

Intangibles as an investment. Firms can invest in some intangible f to decrease their marginal cost of production, now written $\varphi^{-1}c(f)$, where $c_f < 0$, in the non-haven country. The tax-deducted share of this investment f is denoted γ. Absent profit-shifting motives, the investment is denoted f_0. The firm's profits are thus given by

$$\pi_i = \left(p_i - \varphi^{-1}c(f_0)\right) q_i(p_i) - f_0 - t^s \left(p_i - \varphi^{-1}c(f_0)\right) q_i(p_i) + t\gamma f_0 .$$

.

Now, assume the cost f is borne in a tax haven in the form of the production of an intangible that is not taxed. Assume, moreover, that this intangible may be imported at an inflated cost $\delta f > f$. The above equation becomes:

$$\pi_i = \left(p_i - \varphi^{-1}c(f_0)\right) q_i(p_i) - f - t^s \left(p_i - \varphi^{-1}c(f)\right) q_i(p_i) + t^s \delta\gamma f .$$

Taking the first-order conditions with respect to f_0 and f, respectively, the optimal investments f and f^* with and without tax avoidance are related by

$$\frac{c_f(f^*)}{c_f(f_0^*)} = \frac{1 - t^s\gamma\delta}{1 - t^s\gamma} < 1 \; .$$

It follows that firms engaged in profit shifting invest more $f^* > f_0^*$ with f^* so that their equilibrium productivity is higher, consistent with the competitive edge put forward in our baseline model.

A.1.2 Tax avoidance and concentration

The Herfindahl index defines concentration in the economy. Formally, if we denote the HHI by $\mathcal{H}$, we have

$$\mathcal{H} = \frac{\sum_{i \le N} s_i^2}{\left(\sum_{i \le N} s_i\right)^2}$$

where N is the overall number of firms that we omit in the expressions below for clarity.

Observing that $\mathcal{H} = 1 - \frac{2\sum_{j \neq k \le N} s_k s_k}{\left(\sum_j s_j\right)^2}$, differentiating the above expression w.r.t. s_k, that $\mathcal{H}$ increases with the sales of firm i means

$$-\left(\sum_{j \neq i; j \le N} s_j\right)\left(\sum_{j \le N} s_j\right) + 2\left(\sum_{j \neq k \le N} s_j s_k\right) > 0$$

which can be rearranged as

$$-\left(\sum_{j \neq i} s_j\right)^2 + 2\left(\sum_{j \neq k \neq i \le N} s_j s_k\right) + s_i\left(\sum_{j \neq i \le N} s_j\right) > 0$$

Introducing the Herfindahl index $\mathcal{H}_{-i} = \frac{\sum_{j \neq i \le N} s_j^2}{\left(\sum_{j \neq i \le N} s_j\right)^2}$ in the absence of firm i, we get:

$$-\mathcal{H}_{-i}\left(\sum_{j \neq i \le N} s_j\right)^2 + s_i\left(\sum_{j \neq i \le N} s_j\right) > 0$$

$$\frac{s_i}{\sum_{j \le N} s_j} > \frac{\mathcal{H}_{-i}}{1 + \mathcal{H}_{-i}}$$

where $\frac{s_i}{\sum_{j \le N} s_j} = \mathcal{S}_i$ is the market share of firm i. The Herfindahl index increases when tax avoidance increases a large firm's market share, such that the above inequality is satisfied. It is straightforward to see that this condition is always verified for the largest firm and never for the smallest one.

A.1.3 The impact of tax avoidance on real production

Real production as a function of productivities and market shares. Real production is given by the CES aggregate

$$\frac{Y}{\mathcal{P}} = \left(\sum_{i=1}^{N} q_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \; . \tag{15}$$

In the presence of additional non-tax distortions, market shares are given by $\mathcal{S}_i = \left(\frac{p_i}{\mathcal{P}}\right)^{1-\sigma}$ and $q_i = \widetilde{\varphi}_i k_i$, we obtain that the allocation of the factor of production between any pair of firms i and j is

$$\frac{k_i}{k_j} = \frac{\mathcal{S}_i^{\frac{\sigma}{\sigma-1}} \widetilde{\varphi}_i^{-1}}{\mathcal{S}_j^{\frac{\sigma}{\sigma-1}} \widetilde{\varphi_j}^{-1}}$$

and thus

$$q_i = \frac{\mathcal{S}_i^{\frac{\sigma}{\sigma-1}}}{\sum_{j \leq N} \mathcal{S}_j^{\frac{\sigma}{1-\sigma}} \widetilde{\varphi_j}^{-1}} K.$$

Plugging the above expression of output into (15) leads to the formula given in the main text:

$$\frac{Y}{\mathcal{P}} / \frac{Y'}{\mathcal{P}'} = \frac{\sum_{i=1}^{i=n} \mathcal{S'}_i^{\frac{\sigma}{\sigma-1}} \widetilde{\varphi}_i^{-1}}{\sum_{i=1}^{i=n} \mathcal{S}_i^{\frac{\sigma}{\sigma-1}} \widetilde{\varphi}_i^{-1}}.$$

Bounds on real output Consider the special case of the real-production expression above for two firms with productivities φ_i and φ_j and market shares $\mathcal{S}$ and $1 - \mathcal{S}$, respectively, we obtain that the change in real output from $\frac{Y}{\mathcal{P}}$ to $\frac{Y'}{\mathcal{P}'}$ induced by any shock that leaves unchanged factor productivities and non-tax distortions are given by

$$\widehat{\left(\frac{Y}{P}\right)} = \frac{Y}{\mathcal{P}} / \frac{Y'}{\mathcal{P}'} = \frac{\mathcal{S'}^{\frac{\sigma}{\sigma-1}} + (\widetilde{\varphi}_i / \widetilde{\varphi}_j)(1 - \mathcal{S}')^{\frac{\sigma}{\sigma-1}}}{\mathcal{S}^{\frac{\sigma}{\sigma-1}} + (\widetilde{\varphi}_i / \widetilde{\varphi}_j)(1 - \mathcal{S})^{\frac{\sigma}{\sigma-1}}}.$$

Evaluating this expression for the largest possible distortions, i.e., $\widetilde{\varphi}_i / \widetilde{\varphi}_j = 0$ and $\widetilde{\varphi}_i / \widetilde{\varphi}_j \to \infty$ pins down the bounds on real output changes.

A.2 Facts on presence in tax havens and audit probability

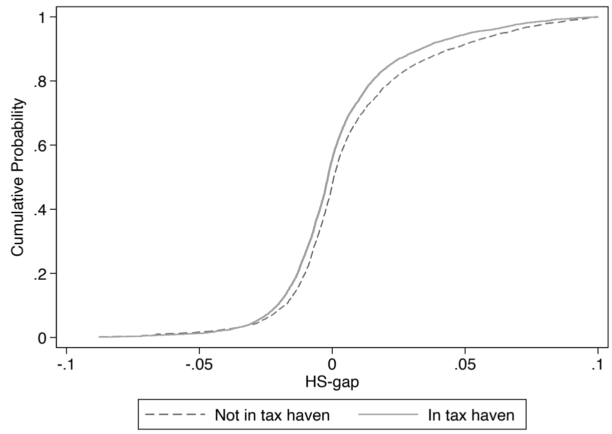
Presence in tax havens. We use the dataset provided by Dyreng and Lindsey (2009) to identify U.S. multinational presence in tax-haven countries. The information is available for a subsample of 7,148 firms spanning 1994-2014. For the tax-haven list, we follow the definition of Hines and Rice (1994) and add the Netherlands. See Souillard (2020a) for a discussion of the data.

Figure A.1 shows the cumulative distribution of the HS-gap measure for the group of MNEs present in tax havens and the group of MNEs that are not. The higher of the two lines in the plot is the cumulative distribution function (cdf) of the HS gap of multinationals that own affiliates in tax-haven countries. The lower line is the same for multinationals with no affiliates in tax havens. A higher cdf is consistent with lower $HS - gap$ for multinationals that have affiliates in tax havens. This evidence supports the idea that our tax avoidance measure captures the firm's aggressive tax planning strategies.[21]

We use the Kolmogorov – Smirnov (KS) test to determine if any differences exist in the distribution of HS gaps for the group of MNEs present in tax havens and the group of MNEs that are not. The KS-test statistic is computed as the largest vertical distance (D) between the two cdfs. We find a maximal distance of 0.1017. This difference is computed to a null

[21] We use the Kolmogorov – Smirnov (KS) test to determine any differences in the distribution of HS gaps for the two groups. The KS-test statistic is computed as the largest vertical distance (D) between the two cdfs. We find a maximal distance of 0.1017. This difference is computed to a null distribution to obtain the p-value for the test, which is 0.000. It indicates overwhelming evidence of a difference between the two distributions.

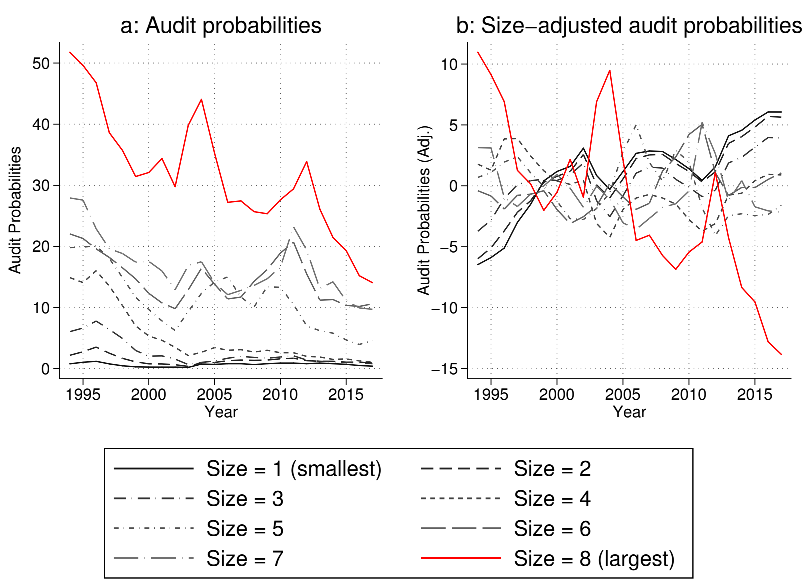
Figure A.1: Cumulative distribution of the HS-gap measure across groups of MNEs



distribution to obtain the p-value for the test, which is 0.000. It indicates overwhelming evidence of a difference between the two distributions.

Audit probabilities. The IRS annual Data-Books disclose data to compute the average audit probability for each of the eight asset classes across our sample period. We compute the audit probability as the number of corporate tax return audits completed in the IRS's fiscal year t for an IRS asset-size group divided by the number of corporate tax returns received in the previous calendar year for the same IRS asset-size group. The size-adjusted audit probabilities are the residuals from a regression of raw probabilities on year and asset-size group dummy variables. The residuals provide information on the deviations from the predicted average audit probability within each year.

Figure A.2: Size-adjusted audit probabilities by asset class



The left panel of Figure A.2 shows the evolution of the audit probabilities as computed using the raw IRS disclosed data. It shows that the probability of an IRS audit has dropped for larger firms in the U.S. but remained relatively constant for the smallest firms. The drop in the audit probability for the smallest firms reporting in the first IRS asset class between 1994 and 2017 is 0.4%, whereas it is over 37% for the largest firms. In panel (b), we display the evolution of the adjusted audit probabilities. It shows a relative decline in the size-adjusted audit probabilities in the eighth class of assets from 1994 to 2017. The value of assets reported by firms in this class amount to $250,000,000 or more and corresponds to the largest firms. However, the decline in the adjusted probabilities is not linear across years, with large variations in the early 2000 and 2010.

OA Online appendix (not intended for publication)

This document is the online appendix for *Corporate tax avoidance and sales: micro evidence and aggregate implications* by Julien Martin, Mathieu Parenti, and Farid Toubal. It reports various robustness checks of the main result of our empirical analysis, namely the causal impact of tax avoidance on individual sales.

OA.1 Clustering in the firm dimension

Abadie et al. (2023) argue that "if the sampling and assignment mechanisms are not clustered, one should not adjust the standard errors for clustering, irrespective of whether such an adjustment would change the standard errors." The sampling and assignment mechanisms are not clustered in our case because the variables of interest are specific to the firm and period as the dependent variable, and our sample covers the universe of publicly listed U.S. firms. Abadie et al. (2023) view clustering as a design problem. A sampling design issue might arise if the sampling follows a two-stage process, where (i) a subset of clusters are randomly sampled and (ii) units are sampled randomly from the sampled clusters. Since our dataset covers the universe of publicly listed U.S. firms, no such problem exists. It might also be an experimental design issue: clusters of units, rather than units, are assigned to treatment. Again, no such issue exists here because the tax avoidance variable is firm-period specific as the dependent variable (firm sales).

Table OA.1: Sales and tax avoidance – Standard errors clustered at firm-Level

Dep. Variable	Log Sales - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.648***	-1.038***		-4.916***		-4.922***
	(0.132)	(0.133)		(0.486)		(1.578)
Share of Intangible	1.167***	1.144***	-0.030**	1.064***	-0.070***	0.845***
	(0.115)	(0.088)	(0.012)	(0.118)	(0.021)	(0.169)
Labor Prod.	0.524***	0.484***	-0.054***	0.396***	-0.046***	0.307***
	(0.025)	(0.038)	(0.004)	(0.033)	(0.006)	(0.082)
Acquisition	1.243***	0.253***	-0.037***	1.150***	-0.006*	0.231***
	(0.035)	(0.018)	(0.004)	(0.039)	(0.003)	(0.023)
MNE Status	1.478***	0.317***	-0.071***	1.314***	-0.015***	0.263***
	(0.041)	(0.028)	(0.004)	(0.051)	(0.004)	(0.035)
Audit Prob. (Adj.)			0.013***		0.003***	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	22,271	18,546	22,271	22,271	18,546	18,546
Adj. R^2	0.527	0.930	0.143		0.607	
KP F-stat.				114.2		9.433

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors clustered at firm-level in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

OA.2 R&D activities.

A legitimate question is whether our results are driven by R&D tax credits, which would lead to very different implications for corporate tax policy. To rule out this possibility, we compute the impact of tax avoidance on sales under the rather extreme scenario of no R&D activity. We, therefore, mute the possibility for firms to alleviate their tax burden through tax credits, allowances, and other forms of R&D-related legal tax reliefs, as well as shifting their profits to foreign low-tax jurisdictions through R&D. We also neutralize the complementarity between tax reliefs and R&D that occurs when firms engaging in aggressive tax planning end up with a higher effective return on R&D and increase their investment and sales.

Information on R&D expenditures is missing for about 40% of the firms and observations in our baseline sample. We run the initial specifications and include the intensity in R&D as an additional control on this smaller sample. We lag the R&D variable by one period as the effects of R&D on firm-level sales may not be contemporaneous.[22] The results reported in Table OA.2 remain robust to the inclusion of this variable. As in section 5, we mute all forms of tax avoidance and show that, under this scenario, concentration (measured by an HHI) drops by about 5.8% in this smaller sample.

[22] Using contemporaneous R&D expenses does not change the main results: an increase in tax avoidance positively affects sales. The coefficient of the contemporaneous R&D variable is, however, not significant.

Table OA.2: Sales and tax avoidance – R&D intensity (one period lag)

Dep. Variable	Log Sales - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.493***	-1.016***		-5.000***		-7.573**
	(0.167)	(0.151)		(0.700)		(3.474)
Share of Intangible	1.286***	1.247***	-0.012	1.214***	-0.037	0.970***
	(0.106)	(0.088)	(0.014)	(0.113)	(0.023)	(0.248)
R&D Intensity (Lag)	-0.000	-0.000	0.000***	0.001	0.000*	0.001
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Labor Prod.	0.661***	0.605***	-0.067***	0.488***	-0.057***	0.235
	(0.028)	(0.043)	(0.005)	(0.051)	(0.007)	(0.205)
Acquisition	1.262***	0.253***	-0.038***	1.157***	-0.004	0.226***
	(0.035)	(0.021)	(0.004)	(0.044)	(0.003)	(0.031)
MNE Status	1.569***	0.261***	-0.074***	1.380***	-0.019***	0.137*
	(0.036)	(0.033)	(0.005)	(0.061)	(0.006)	(0.076)
Audit Prob. (Adj.)			0.010***		0.001**	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	13,493	11,135	13,493	13,493	11,135	11,135
Adj. R^2	0.566	0.940	0.177		0.646	
KP F-stat.				81.36		5.525

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

OA.3 Lobbying on tax issues and sales.

Tables OA.3 and OA.4 show our main results remain when we account for firms' lobbying activities on tax issues (Table OA.3) or when we reduce the sample to firms that do not lobby on tax (Table OA.4).

Arayavechkit et al. (2018) show that the firm size and effective tax rate positively correlate with their lobbying activities. We thus verify that this potential confounding factor does not bias our results. We use data on lobbying activities of U.S. firms from Kim (2018) to create an indicator that provides information on the firm's participation in lobbying on taxation or the internal revenue code. More specifically, we can track the lobbying issues of all U.S. firms filing lobbying disclosure forms. We focus on accounting and taxation issues and merge this information with Compustat using the firms' identifier provided by Kim (2018). As the dataset spans 1999-2017, the sample reduces to 5,809 firms, 11.5% of which participated in lobbying activities in the last six-year period of our estimation sample. Tables OA.3 and Table OA.4 in the Online Appendix report the results. The first two columns of Table OA.3 show that the results with this subsample are similar to our baseline results. We then include the lobby indicator variable in the specifications to control the activity of lobbying on taxation or internal revenue code. Firms active in lobbying on taxation issues are larger than firms that do not participate in lobbying activities, but including this variable does not influence the causal effect of CTA on sales. We show that lobbying has no impact on the level of CTA. Moreover, including the lobbying dummy variable does not influence the effects of the residual audit probability on the firm's aggressive tax-planning strategies. Another way to ensure that firms' lobbying activities do not influence our results is to estimate the impact of tax avoidance on sales in a sample of firms that are not active in lobbying activities. The causal effect of tax avoidance on sales survives in this reduced sample as shown in Table OA.4.

Table OA.3: Sales and Tax Avoidance – Firm Lobbying on Tax Issues

Dep. Variable	Log Sales - End of Period							
	Reproduction of the Baseline				Indicator for Firm Lobbying on Taxation or Internal Revenue Code			
	2SLS							
	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap		-10.212***		-5.975***		-9.440***		-5.885***
		(0.850)		(1.663)		(0.781)		(1.636)
Share of Intangible	-0.013	0.681***	-0.098***	0.557**	-0.013	0.750***	-0.098***	0.561**
	(0.015)	(0.149)	(0.029)	(0.229)	(0.015)	(0.138)	(0.029)	(0.226)
Labor Prod.	-0.059***	0.002	-0.049***	0.177*	-0.059***	0.032	-0.049***	0.181**
	(0.004)	(0.048)	(0.008)	(0.092)	(0.004)	(0.045)	(0.008)	(0.090)
Acquisition	-0.038***	0.946***	-0.012***	0.136***	-0.038***	0.844***	-0.012***	0.136***
	(0.005)	(0.062)	(0.004)	(0.032)	(0.005)	(0.057)	(0.004)	(0.032)
MNE Status	-0.082***	0.779***	-0.015***	0.189***	-0.082***	0.630***	-0.015***	0.191***
	(0.005)	(0.070)	(0.005)	(0.039)	(0.005)	(0.064)	(0.005)	(0.038)
Audit Prob. (Adj.)	0.020***		0.004***		0.020***		0.004***	
	(0.002)		(0.001)		(0.002)		(0.001)	
Lobby (Tax)					0.003	2.186***	0.005	0.141***
					(0.003)	(0.044)	(0.003)	(0.032)
Sector × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	Yes	Yes	No	No	Yes	Yes
Obs.	17,021	17,021	14,514	14,514	17,021	17,021	14,514	14,514
Adj. R^2	0.167		0.632		0.167		0.632	
KP F-stat.		132.8		12.34		132.1		12.41

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Table OA.4: Sales and tax Avoidance – Without the sample of firms lobbying on tax issues

Dep. Variable	Log Sales - End of Period			
	2SLS			
	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap		-9.558***		-6.806***
w		(0.794)		(1.911)
Share of Intangible	-0.013	0.794***	-0.114***	0.351
	(0.016)	(0.150)	(0.033)	(0.296)
Labor Prod.	-0.061***	0.010	-0.051***	0.132
	(0.004)	(0.047)	(0.009)	(0.109)
Acquisition	-0.037***	0.836***	-0.012**	0.128***
	(0.005)	(0.060)	(0.005)	(0.039)
MNE Status	-0.086***	0.595***	-0.017***	0.163***
	(0.005)	(0.068)	(0.005)	(0.046)
Audit Prob. (Adj.)	0.021***		0.004***	
	(0.002)		(0.001)	
Sector × Year FE	Yes	Yes	Yes	Yes
Firm FE	No	No	Yes	Yes
Obs.	15,374	15,374	12,804	12,804
Adj. R^2	0.170		0.626	
KP F-stat.		131.5		11.94

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

OA.4 Alternative time windows and alternative variables.

Alternative time windows. We construct the HS gap by aggregating its components over six periods of four years. Table OA.5 shows that our findings hold when we use a six- or eight-year window. Note that the effects have the correct signs but are insignificant in the specifications, including firm-fixed effects. This observation is expected because our identifications rely on three or four periods using these alternative time windows.

Table OA.5: Sales and tax avoidance – Various windows and variables

Dep. Variable	Log Sales - End of Period											
	Four-year period				Six-year period				Eight-year period			
	OLS		2SLS (2^{nd} Stage)		OLS		2SLS (2^{nd} Stage)		OLS		2SLS (2^{nd} Stage)	
HS tax gap	-0.93***	-0.37***	-1.73***	-1.73***	-1.09***	-0.57***	-2.40***	-2.47***	-1.19***	-0.51***	-2.94***	-3.03*
	(0.044)	(0.041)	(0.172)	(0.505)	(0.065)	(0.087)	(0.298)	(0.891)	(0.101)	(0.117)	(0.353)	(1.714)
Obs.	22,271	18,546	22,271	18,546	14,409	10,615	14,409	10,615	10,593	6,798	10,593	6,798
Adj. R^2	0.536	0.951	0.396	-0.184	0.526	0.954	0.332	-0.269	0.521	0.954	0.276	-0.482
KP F-stat.			124.6	11.62			63.85	6.721			62.75	2.680
HS Gap Indicator	0.97***	0.14***	7.33***	3.79**	1.08***	0.18***	10.27***	9.77	1.21***	0.19***	11.33***	2.28**
	(0.025)	(0.012)	(1.019)	(1.828)	(0.031)	(0.017)	(1.946)	(11.783)	(0.037)	(0.024)	(1.693)	(0.916)
Obs.	22,271	18,546	22,271	18,546	14,409	10,615	14,409	10,615	10,593	6,798	10,593	6,798
Adj. R^2	0.514	0.950	-1.236	-4.503	0.508	0.952	-3.064	-32.837	0.507	0.953	-3.447	-1.308
KP F-stat.			54.84	4.919			25.97	0.685			40.43	9.501
HS tax gap (MVA)	-0.96***	-0.27***	-3.40***	-1.79***	-1.13***	-0.42***	-5.95***	-11.51	-1.08***	-0.40***	-6.01***	-7.83
	(0.026)	(0.019)	(0.364)	(0.532)	(0.043)	(0.037)	(0.900)	(16.201)	(0.049)	(0.050)	(0.725)	(8.396)
Obs.	22,271	18,546	22,271	18,546	14,409	10,615	14,409	10,615	10,593	6,798	10,593	6,798
Adj. R^2	0.539	0.951			0.531	0.954			0.522	0.954		
KP F-stat.			103.1	15.62			40.10	0.480			62.70	0.833
Sector × Period FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sample years: 1994-2017 (24 years). The dependent variable is the firm's log sales at the end of the four-, six-, and eight-year windows. The HS tax gap and HS tax gap (MVA) variables are centered and standardized to ease comparisons. OLS and 2SLS estimates with robust standard errors in parentheses. The share of intangibles, labor productivity, and the three dummy variables interact with the audit probability in the first stage and the HS tax gap in the second. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

In Table OA.6, we report the results using a long difference on a sample of firms with positive sales in our sample's first and last periods. The OLS and 2SLS results confirm the positive impact of tax avoidance on sales over a long period.

Table OA.6: Sales and Tax Avoidance – Long Difference

Dep. Variable	Δ Log Sales - End of Period		
	OLS	2SLS	
		1^{st} Stage	2^{nd} Stage
Δ HS tax gap	-2.490***		-4.727***
	(0.401)		(1.765)
Δ Share of Intangible	1.951***	0.006	1.869***
	(0.220)	(0.024)	(0.231)
Δ Acquisition	0.123	0.008	0.154*
	(0.080)	(0.010)	(0.084)
Δ MNE	0.338***	-0.007	0.344***
	(0.083)	(0.011)	(0.087)
Δ Labor Prod.	0.232***	-0.032*	0.160*
	(0.083)	(0.016)	(0.092)
Δ Audit Prob. (Adj.)		0.005**	
		(0.002)	
Sector FE	Yes	Yes	Yes
Obs.	1,106	1,106	1,106
Adj. R^2	0.224	0.0811	
KP F-stat.			5.411

Sample years: 1994-2017. The dependent variable is the firm's log sales at the end of the first and the last 6-year windows. OLS and 2SLS estimates with robust standard errors in parentheses. First-stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Alternative variables. Our findings are not driven by the scalar chosen to construct the HS indicator. In the baseline, we scale the difference between the taxes paid and their statutory counterpart by the book value of assets. Henry and Sansing (2018) alternatively propose scaling the measure with the market value of assets. The results using this alternative measure, presented in the second panel of Table OA.5, are similar to the baseline regressions. In the third panel of Table OA.5, we present the results using an indicator variable that takes the value of 1 when firms are tax-favored – the numerator is negative– and 0 otherwise, which allows us to have a scale-free measure of avoidance. Tax-avoiding firms have larger sales both in the OLS and 2SLS specifications.

We further show in Table OA.7 that using the average sales within a time window rather than the sales at the end of the period as an explanatory variable does not affect the results.

Table OA.7: Sales and tax avoidance – OLS and 2SLS estimates

Dep. Variable	Log Sales - Average					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.466***	-0.827***		-4.579***		-4.653***
	(0.115)	(0.096)		(0.468)		(1.367)
Share of Intangible	1.102***	1.014***	-0.030***	1.006***	-0.070***	0.720***
	(0.080)	(0.066)	(0.011)	(0.086)	(0.019)	(0.144)
Labor Prod.	0.512***	0.505***	-0.054***	0.393***	-0.046***	0.330***
	(0.016)	(0.028)	(0.003)	(0.028)	(0.005)	(0.068)
Acquisition	1.154***	0.194***	-0.037***	1.067***	-0.006*	0.172***
	(0.027)	(0.015)	(0.004)	(0.032)	(0.003)	(0.019)
MNE Status	1.480***	0.352***	-0.071***	1.328***	-0.015***	0.298***
	(0.026)	(0.022)	(0.004)	(0.040)	(0.004)	(0.030)
Audit Prob. (Adj.)			0.013***		0.003***	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	22,271	18,546	22,271	22,271	18,546	18,546
Adj. R^2	0.534	0.947	0.143	0.385	0.610	-0.791
KP F-stat.				124.6		11.62

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the logarithm of the firm's average sales across the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Heterogeneity across sectors and firms. We investigate the heterogeneity in the impact of tax avoidance on sales across sectors and firms. We find that the positive impact is pervasive in manufacturing and services industries and is magnified for high-productivity firms and those that increased their share of intangible assets (Table OA.8, Table OA.9). Furthermore, we show that our results are not driven by firms incorporated in Delaware (Table OA.10).

Table OA.8: Sales and tax avoidance – Across Sectors

Dep. Variable	Log Sales - End of Period							
	2SLS							
	Manufacturing				Services			
	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap		-4.394***		-5.236**		-4.523***		-5.712**
		(0.725)		(2.605)		(0.629)		(2.311)
Share of Intangible	0.004	1.222***	-0.024	1.008***	-0.053***	0.947***	-0.100***	0.601**
	(0.015)	(0.131)	(0.023)	(0.182)	(0.016)	(0.115)	(0.030)	(0.290)
Labor Prod.	-0.089***	0.706***	-0.065***	0.378**	-0.040***	0.237***	-0.036***	0.198**
	(0.006)	(0.069)	(0.010)	(0.180)	(0.004)	(0.030)	(0.007)	(0.090)
Acquisition	-0.034***	1.164***	-0.006	0.235***	-0.041***	1.059***	-0.004	0.211***
	(0.005)	(0.046)	(0.004)	(0.028)	(0.006)	(0.050)	(0.005)	(0.038)
MNE Status	-0.069***	1.578***	-0.021***	0.248***	-0.071***	1.063***	-0.009**	0.265***
	(0.005)	(0.061)	(0.007)	(0.063)	(0.006)	(0.057)	(0.005)	(0.041)
Audit Prob. (Adj.)	0.011***		0.002**		0.015***		0.003**	
	(0.001)		(0.001)		(0.002)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	Yes	Yes	No	No	Yes	Yes
Obs.	9,949	9,949	8,443	8,443	10,730	10,730	8,782	8,782
Adj. R^2	0.185		0.664		0.125		0.567	
KP F-stat.		61.05		5.290		54.51		4.637

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

The first-stage results confirm that the adjusted audit probability remains a strong predictor of tax avoidance. Overall, the industry-specific analysis suggests that the positive effect of tax avoidance on sales described above is important in the manufacturing and services industries.

The results so far do not provide information on the observable characteristics of firms that magnify or reduce the effect of tax avoidance on firm-level sales. We interact the HS_{is} tax avoidance measure with the remaining firm-level attributes that enter the baseline OLS and 2SLS second-stage regressions. These attributes are interacted with the adjusted probabilities in the first-stage regressions. The results are reported in Table OA.9.

Our main results hold. We find that firms that largely benefited from the reduction in the IRS audit probability and therefore intensified their aggressive tax-planning strategies have increased their sales over the sample period. Overall, the second-stage results of the specification that uses sector and period fixed effects suggest that the effect of tax avoidance is larger in multinational firms than in domestic firms.[23] Exploiting the firm variation by using firm-specific effects, we find the effect of tax avoidance is larger in firms that increased

[23]Notice the interaction term between the HS-gap variable and the MNE-status indicator cannot be identified when using firm fixed effects.

Table OA.9: Sales and Tax Avoidance – With Interaction Terms

Dep. Variable	Log Sales - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap (centered)	-2.525***	-0.955***		-7.138***		-5.710***
	(0.196)	(0.174)		(1.077)		(1.542)
Share of Intangible (centered)	1.150***	1.125***	-0.008	1.083***	-0.048***	0.871***
	(0.082)	(0.079)	(0.007)	(0.088)	(0.014)	(0.129)
Labor Prod. (centered)	0.521***	0.477***	-0.020***	0.425***	-0.008***	0.438***
	(0.018)	(0.032)	(0.001)	(0.029)	(0.002)	(0.038)
Acquisition	1.185***	0.246***	-0.004	1.159***	0.006*	0.274***
	(0.032)	(0.019)	(0.003)	(0.036)	(0.003)	(0.028)
MNE Status	1.366***	0.289***	-0.002	1.360***	0.015***	0.365***
	(0.053)	(0.028)	(0.005)	(0.066)	(0.006)	(0.050)
Interaction with						
– Share of Intangible	-2.550***	-1.805***	-1.145***	-7.818***	-1.334***	-8.117***
	(0.800)	(0.624)	(0.201)	(1.817)	(0.267)	(2.511)
– Labor Prod.	-0.096	0.096	-0.273***	-1.366***	-0.225***	-0.974***
	(0.073)	(0.067)	(0.020)	(0.327)	(0.021)	(0.364)
– MNE Status	-2.295**	-0.707**	0.583***	0.455	0.635***	2.332*
	(0.996)	(0.315)	(0.105)	(1.551)	(0.112)	(1.217)
– Acquisition	-1.305***	-0.146	0.511***	1.076	0.323***	1.393**
	(0.394)	(0.207)	(0.064)	(0.749)	(0.067)	(0.657)
Audit Prob. (Adj.)			0.006***		0.002***	
			(0.001)		(0.000)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	22,271	18,546	22,271	22,271	18,546	18,546
Adj. R^2	0.535	0.931	0.735		0.850	
KP F-stat.				84.36		22.80

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. The share of intangibles, labor productivity, and the three dummy variables are interacted with the audit probability in the first stage and with the HS tax gap in the second. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

their share of intangible assets. This finding offers a new channel through which the increase in intangibles among a few firms has increased concentration (Crouzet and Eberly, 2019).

In Table OA.10, we show our main findings hold if we exclude firms incorporated in Delaware from our analysis.

Table OA.10: Sales and tax avoidance – without Delaware

Dep. Variable	Log Sales - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.228***	-1.002***		-4.514***		-5.954*
	(0.139)	(0.148)		(0.600)		(3.137)
Share of Intangible	0.932***	1.077***	-0.067**	0.738***	-0.119***	0.455
	(0.168)	(0.138)	(0.028)	(0.186)	(0.046)	(0.489)
Labor Prod.	0.547***	0.480***	-0.072***	0.375***	-0.061***	0.180
	(0.028)	(0.048)	(0.006)	(0.049)	(0.011)	(0.195)
Acquisition	1.350***	0.276***	-0.047***	1.229***	-0.001	0.269***
	(0.047)	(0.029)	(0.006)	(0.055)	(0.006)	(0.041)
MNE Status	1.566***	0.317***	-0.083***	1.368***	-0.010*	0.272***
	(0.046)	(0.038)	(0.006)	(0.066)	(0.006)	(0.052)
Audit Prob. (Adj.)			0.017***		0.002*	
			(0.002)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Sample	Without Delaware as Incorporation State					
Obs.	8,683	7,223	8,683	8,683	7,223	7,223
Adj. R^2	0.540	0.936	0.175		0.633	
KP F-stat.				81.20		3.698

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log sales at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

OA.5 Dependent variables: markup and employment.

De Loecker et al. (2020) show aggregate markups have increased in the U.S. since 1980. They find that an increase in the upper tail of the markup distribution and an increase in the market share of high-markup firms drives the trend. This appendix investigates whether corporate tax avoidance contributed to this trend.

To do so, we use the baseline measure of markups proposed by De Loecker et al. (2020). Markups are thus computed as the product between the output elasticity and the sales-to-costs ratio. Sales and costs are directly observable in Compustat data (variables SALE and COGS). We use the sector and year output elasticity estimated by De Loecker et al. (2020) and displayed on their website.[24] In our sample, aggregate markups have doubled over the period– a fact that is consistent with De Loecker et al. (2020).

In Table OA.11, we examine the impact of tax avoidance on markups. The specifications are similar to the ones used to analyze the relationship between sales and tax avoidance. We do not find evidence of an influence of corporate tax avoidance on the markup levels. Whether we identify the effect of tax avoidance using the variation across or within firms and within sector and period, this result holds.[25]

Indeed, if one uses the same counterfactual exercise as in the paper to compute the aggregate markups without tax avoidance, the figure barely changes relative to the aggregate markups with tax avoidance. Specifically, the aggregate markup would be 0.1% lower without tax avoidance. The results thus suggest that tax avoidance has not systematically benefited high-markup firms. This finding is hardly surprising because several large firms engaged in tax avoidance in our data do not report the highest markup in their industry. Moreover, this observation echoes anecdotal evidence on the low-margin pricing strategies of superstar web retailers and other successful digital companies that are not profitable during the first years upon entry. Still, low markups are not synonymous with low market power. See De Loecker et al. (2020) for related discussions.

In Table OA.12, we show that tax avoidance has a positive and significant impact on firm-level employment. Our results suggest that tax avoidance can increase employment by reducing effective marginal costs and increasing output.

[24] The results are robust if one instead calibrates the output elasticity to .85 as in some of De Loecker et al. (2020) robustness checks.

[25] This prediction is valid for markups over effective costs. It is unclear whether the method used to measure markups fully accounts for the effective costs. If anything, the measured marginal cost is biased upward for tax-avoiding firms. In that case, the measured markup would decrease with tax avoidance (and less so for oligopolistic firms).

Table OA.11: Markups and tax avoidance – OLS and 2SLS estimates

Dep. Variable	Markups - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	0.098	0.031		-0.016		0.893
	(0.121)	(0.224)		(0.378)		(1.814)
Share of Intangible	0.077	-0.140	-0.029***	0.072	-0.059***	-0.083
	(0.073)	(0.127)	(0.011)	(0.073)	(0.017)	(0.154)
Labor Prod.	0.120***	0.117***	-0.053***	0.114***	-0.047***	0.158*
	(0.013)	(0.032)	(0.003)	(0.022)	(0.006)	(0.093)
Acquisition	-0.082***	-0.053**	-0.037***	-0.087***	-0.006**	-0.047*
	(0.022)	(0.024)	(0.004)	(0.025)	(0.003)	(0.025)
MNE Status	0.143***	0.010	-0.069***	0.135***	-0.016***	0.023
	(0.022)	(0.037)	(0.004)	(0.031)	(0.004)	(0.049)
Audit Prob. (Adj.)			0.012***		0.003***	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	22,219	18,511	22,219	22,219	18,511	18,511
Adj. R^2	0.155	0.581	0.139		0.612	
KP F-stat.				118.5		11.57

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's markup as computed by De Loecker et al. (2020). The markup is taken at the end of the four-year window. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Table OA.12: Employment and tax avoidance – OLS and 2SLS estimates

Dep. Variable	Log employment - End of Period					
	OLS		2SLS			
			1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage
HS tax gap	-2.515***	-0.905***		-4.689***		-5.369***
	(0.123)	(0.088)		(0.493)		(1.795)
Share of Intangible	1.102***	1.033***	-0.031***	1.002***	-0.075***	0.670***
	(0.081)	(0.071)	(0.011)	(0.087)	(0.019)	(0.180)
Labor Prod.	-0.456***	-0.399***	-0.054***	-0.578***	-0.044***	-0.597***
	(0.017)	(0.030)	(0.003)	(0.030)	(0.006)	(0.084)
Acquisition	1.244***	0.282***	-0.037***	1.155***	-0.005	0.261***
	(0.028)	(0.015)	(0.004)	(0.033)	(0.003)	(0.021)
MNE Status	1.453***	0.321***	-0.069***	1.302***	-0.014***	0.262***
	(0.027)	(0.024)	(0.004)	(0.041)	(0.004)	(0.035)
Audit Prob. (Adj.)			0.012***		0.002***	
			(0.001)		(0.001)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	No	Yes	Yes
Obs.	21995	18303	21995	21995	18303	18303
Adj. R^2	0.510	0.940	0.142		0.615	
KP F-stat.				119.3		8.900

Sample years: 1994-2017 (6 windows of 4 years). The dependent variable is the firm's log employment as computed. OLS and 2SLS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Table OA.13: Sales and tax avoidance – using post-1996 as an alternative post-treatment period

Dep. Variable	Log Sales - End of Period					
	Diff-in-Diff	2SLS		Diff-in-Diff	2SLS	
		1^{st} Stage	2^{nd} Stage	1^{st} Stage	2^{nd} Stage	
HS tax gap			-4.956***			-7.838***
			(1.120)			(2.474)
Share of Intangible	1.539***	-0.026**	1.409***	1.416***	-0.048**	1.037***
	(0.110)	(0.011)	(0.108)	(0.127)	(0.021)	(0.242)
Labor Prod.	0.911***	-0.055***	0.637***	0.605***	-0.039***	0.302***
	(0.023)	(0.004)	(0.065)	(0.043)	(0.006)	(0.106)
Acquisition	1.101***	-0.023***	0.986***	0.260***	-0.009***	0.193***
	(0.032)	(0.003)	(0.040)	(0.020)	(0.003)	(0.035)
MNE Status	1.301***	-0.009***	1.258***			
	(0.050)	(0.002)	(0.056)			
MNE × $Post_{1996}$	0.268***	-0.054***		0.115***	-0.015***	
	(0.063)	(0.005)		(0.031)	(0.003)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes
Obs.	15,441	15,441	15,441	12,165	12,165	12,165
Adj. R^2	0.460	0.155		0.925	0.494	
KP F-stat.			117			11.41

The dependent variable is the firm's log sales at the end of the six-year window. We have two periods of analysis starting in 1993. OLS and 2SLS estimates with robust standard errors in parentheses. First-stage Kleibergen-Paap Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.