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

Keywords: Tax avoidance, industry concentration, IRS Audit Probability

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Corporate tax avoidance and industry concentration*

Julien Martin† Mathieu Parenti‡ Farid Toubal§

June 23, 2021

Abstract

This paper investigates the influence of corporate tax avoidance (CTA) on industry concentration in the U.S. since the mid-1990s. A simple model shows CTA increases concentration if (*i*) CTA gives a competitive advantage to avoiding firms, and (*ii*) CTA of large relative to small firms increases. We find a positive and causal impact of CTA on firm-level sales using three alternative identification strategies. We then show CTA increases more among the largest firms in most industries, which reinforces their dominant position. In key industries, the differences in tax aggressiveness between large and small firms explain 10% to 30% of the increase in concentration over the last 25 years. CTA-induced changes in the CR4 index influence industrial real output to an extent that is relevant at the macroeconomic scale.

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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

A wealth of empirical evidence suggests concentration among U.S. firms has increased since the early 90s.[1] A similar upward trend occurs for aggressive corporate tax avoidance (CTA) and profit shifting of U.S. firms.[2] This paper shows the relative increase in tax avoidance by large corporations has contributed to the increase in concentration across US industries.

We first provide causal evidence on the impact of tax avoidance on firm-level sales. We then demonstrate that the positive effect of tax avoidance on sales has mostly benefited the largest companies and thus fostered industry concentration across a large number of industries. This new finding is critical for two reasons. First, it sheds light on a new channel driving concentration - tax avoidance - that has been overlooked so far by the literature, which has discussed the role of technology (Autor et al., 2020), increasing barriers to entry, lax or ineffective antitrust enforcement (Gutiérrez and Philippon, 2018; Philippon, 2019). Second, it illustrates how the implications of CTA go beyond the erosion of government tax revenues.[3] CTA gives a competitive edge to avoiding firms, which distorts competition. By affecting the granularity of the economy, tax avoidance may also have end effects on various

[1]A handful of businesses account for most of the sales in each sector, a phenomenon that drives economy-wide concentration and has been described in many studies, including important papers such as Autor et al. (2017), Grullon et al. (2019), Furman and Orszag (2015), Philippon (2019), De Loecker et al. (2020), and Shambaugh et al. (2018).

[2]We define CTA as a broad spectrum of activities ranging from the exploitation of uncertainties or variability in the interpretation of the tax law to arrangements or schemes designed specifically to reduce taxable income that may be illegal, including tax evasion (Hanlon and Heitzman, 2010; Chen et al., 2010). For recent discussions on the spread and magnitude of tax avoidance, see Dyreng et al. (2014), Blouin and Robinson (2019), and Clausing (2016; 2020).

[3]See Clausing (2016) or Zucman (2014) about the government losses induced by the tax avoidance of large multinationals.

outcomes such as the political influence of large firms (Zingales, 2017) or the exposure of the economy to granular shocks (Gabaix, 2011).

The paper starts with a theoretical discussion of the impacts of tax avoidance on firm-level sales and industry concentration. In our stylized model, firms are heterogeneous in terms of productivity and in their ability to reduce pre-tax profits. Profit-maximizing sales are distorted as soon as firms are able to manipulate the production costs used in the calculation of 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.

The competitive edge offered by tax avoidance becomes relevant for industry concentration as soon as firms differ in tax-avoidance intensity. If tax avoidance is facilitated uniformly, firms' profitability increases, but their relative sales are not affected. Instead, if large firms adopt more aggressive tax-avoidance strategies, concentration increases.

A key contribution of our analysis is to provide evidence for a causal relationship from firm-level tax avoidance to sales. To this end, we follow the methodology of Henry and Sansing (2018) to measure tax avoidance, and we propose three alternative strategies using the rich structure of the Compustat dataset. First, we use individual fluctuations in audit probability over time and across firms to identify the effect of tax avoidance on firm-level sales. This strategy is inspired by Hoopes et al. (2012), who find a negative correlation between IRS audit probability and tax avoidance. Because the IRS has a higher audit rate for larger companies, we construct residual audit probabilities, which breaks the mechanical correlation between the 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. The result is 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 of firms on taxation issues. All specifications further include sector and year fixed effects, and are robust to adding firm-fixed effects, which rule out confounding factors that may drive avoidance and sales together.

Our second and third identification strategies exploit a change in US legislation (SFAS 131) that exempts firms from reporting the precise geographic distribution across jurisdictions of their earnings after 1998. The second strategy relies on a difference-in-differences estimation of the impact of the SFAS 131 reform on tax-avoidance behavior and sales of firms active abroad relative to other firms, before and after the reform. Consistent with Hope et al. (2013), we find the reform has enhanced the tax avoidance of firms with foreign operations. The third strategy uses the implementation of the legislation to instrument the change in tax avoidance and show its end effect on sales. Results obtained from the SFAS 131 reform confirm the causal impact of tax avoidance on sales.

The causal impact of tax avoidance on sales is a necessary condition for CTA to contribute to the increase in industry concentration. It is, however, not sufficient, as clarified by our theoretical section: for concentration to increase within an industry, large firms must avoid more corporate income taxes than smaller firms. We show the change in relative tax avoidance is consistent with the observed evolution of industry concentration in the vast majority of industries. They account for almost three-quarters of aggregate sales. In other industries, which are relatively smaller, our mechanism is not at work. We use our theoretical framework and the causal estimates of the impact of avoidance on sales to quantify the contribution of tax avoidance on concentration. Our main takeaway from this exercise is that a change in tax avoidance alone explains about 6% of the increase in concentration measured by the evolution of the four-firm concentration ratio (CR4) between 1994 and 2017. The impacts are highly heterogeneous across industries. In some industries, such as chemicals, non-store retailers, air transportation, or the manufacturing of electronic products, tax avoidance explains about one-fifth of the increase in the market share of the four largest firms. Eventually, we use our model to assess the potential impact of tax avoidance on real production. We find movements in CTA induce swings in industries' output to an extent that is relevant at the macroeconomic scale.

Taken together, we believe our identification strategies provide compelling evidence for a causal effect of tax avoidance on sales. Our results do not dismiss the idea that large firms are more likely to avoid taxes. To the contrary, results from our counterfactual experiments show both effects are at work, reinforcing each other. In many industries, large firms have been more likely (or have more incentive) to avoid taxes. Tax avoidance gives them a competitive advantage, which reinforces their dominant position and increases industry concentration.

This paper makes several contributions to the literature. To the best of our knowledge, our paper is the first to analyze the impact of tax avoidance on industry concentration. Important contributions provide some explanation for the increase in concentration (Philippon, 2019). Some studies suggest increased concentration is driven by firms with high productivity gains. Autor et al. (2020) show the upward trend in concentration is due to the growth of *superstar* firms that are more productive. According to Crouzet and Eberly (2019), the increase in intangible capital is concentrated among industry leaders, and is thus closely related to the increase in industry concentration. By showing the impact of tax avoidance on sales is stronger for firms with a high share of intangibles, we offer an additional narrative for the key role of intangibles for concentration. Other studies show that increasing barriers to entry or lax or ineffective antitrust enforcement is also driving concentration (Gutiérrez and Philippon, 2018; Philippon, 2019). In this paper, we document that tax avoidance gives a competitive edge to large profit-shifting firms relative to smaller firms, leading to concentration.

Our results show tax and competition policy are necessarily intertwined, as illustrated by the 2016 ruling of the European Commission, which found the Irish government distorted competition policy by giving Apple significant tax breaks.[4] The case of Apple is not isolated.

[4] 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 $(\cdots)$ 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).

The European Commission took decisions against Luxembourg (for unlawful tax benefits presented to Fiat and Amazon) and the Netherlands (for illegal tax breaks given to Starbucks).[5] In a related vein, Bauch et al. (2018) show how tax advantages have allowed online retailers to maintain a price advantage over brick-and-mortar retailers, which has shaped the US retail industry. The previously cited literature largely discusses the normative aspects of concentration, which is beyond the scope of this paper. Industry concentration may reflect market power or efficiency, with different implications for consumers' welfare (see Syverson, 2019, for a discussion).[6] We show in this paper that this trend is partly driven by aggressive tax-planning strategies that fall into the gray area or are illegal.

Our paper is also related to the literature documenting the increasing tax avoidance of corporations (Zucman, 2014; Dyreng et al., 2014).[7] A few papers have documented a positive correlation between tax avoidance and firm size (Gumpert et al., 2016; Davies et al., 2018) or their product market power (Kubick et al., 2014). We show their aggressive tax strategies reinforces the dominant position of the largest firms. Some important papers in the accounting literature show tax enforcement plays a tremendous role in curbing opportunities for tax avoidance (Hoopes et al., 2012; Nessa et al., 2020; De Simone et al., 2019). We confirm that U.S. firms undertake more aggressive tax positions as they face laxer tax enforcement. By giving a competitive advantage to larger firms, the laxer tax enforcement has real effects on the U.S. economy. Last, the link we draw between corporate taxation and the distribution of activities in the U.S. is related to Arayavechkit et al. (2018), who show firms' lobbying for capital-based tax benefits generates capital misallocation.

The rest of the paper is organized as follows. In section 2, we presents a stylized model on the link between tax avoidance, sales, and industry concentration. In section 3, we describes

[5]See Hrushko (2017) for a detailed discussion of tax breaks and competition policy in the E.U.

[6]As in De Loecker et al. (2020), we find aggregate markups have doubled over the period of analysis. In the Online Appendix OA.3, we show CTA has not contributed to this trend. This finding is consistent with the observation in the data that firms engaged in aggressive tax-planning strategies are larger on average but do not charge higher markups.

[7]This trend is tightly linked to mounting evidence of profit shifting by multinational firms (Swenson, 2001; Bartelsman and Beetsma, 2003; Clausing, 2003; Bernard et al., 2006; Desai and Hines Jr, 2002; Egger et al., 2010; Dharmapala, 2014; Cristea and Nguyen, 2016; Davies et al., 2018; Bilicka, 2019).

the firm-level data and the construction of our indicator of tax avoidance. We present a few facts on the evolution of concentration, tax avoidance, and their interplay. We describe our empirical strategy to assess the causal effect of tax avoidance on sales and present the baseline results in section 4. We quantify the importance of tax avoidance for concentration and real output in section 5. We then show the robustness of our results in section 6. We conclude in section 7.

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. Whereas tax avoidance is modelled in a reduced-form way, we show it is consistent with a range of micro-foundations found in the literature (see Appendix A.1).

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 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 is able to inflate the production costs used in the calculation of 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. The increase in sales is achieved by lower costs and prices in our simple framework, but 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 type of mechanism is detailed in Appendix A.1 when addressing profit shifting through intangibles.

Micro-foundations. This reduced-form modelling of tax avoidance is consistent with various profit-shifting techniques. Firms can manipulate the value of intra-firm transactions (transfer-pricing) to shift their tax base to low-tax jurisdictions. For instance, a firm may inflate its costs by importing from an affiliate located in a tax haven a good or a service beyond its "arm's length" value. Although we discuss the case of imports, the same mechanism is at play for a firm based in a non-haven jurisdiction that would underprice its exports to a tax haven to shift its profits. When the affiliate's activity boils down to declaring profits on paper, circumventing corporate taxes entirely, $\theta_i = 1 + p_I\varphi_i$, where p_I is the transfer price of the intra-firm transaction. The transfer price p_I can easily be endogeneized as a function of φ_i through a concealment cost function as in Davies et al. (2018). Again, we do not need to take a stand on the relationship between θ_i and φ_i to show the impact of tax avoidance on concentration. Instead, the (empirically estimated) correlation between the within-firm change in tax avoidance and firm size is key.

A profit-shifting firm may also engage in debt shifting. To do so, it may borrow from an affiliate located in a tax haven and deduct interest payments in the non-haven country, while declaring them in a tax haven where they end up not being taxed. In this event, θ_i is simply the per-input-unit interest payment paid to the affiliate. Whereas profit shifting can directly affect a firm's effective marginal cost of production, our framework is also consistent with a productivity gain resulting from a higher investment induced by tax avoidance. For instance, a firm may inflate the deductible share of its investment by importing high-valued services from an affiliate where its intangible assets are located. This strategy can increase its investment and decrease its marginal cost of production. See Appendix A.1 for the derivations of (1) in the presence of profit shifting through good/service mispricing and debt shifting.

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 price p_i is

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

.

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.

From tax avoidance to sales premium. 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:

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

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 ($\kappa(\boldsymbol{\varphi}, \boldsymbol{\theta})$).

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

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

This expression shows how differences in the intensity of tax avoidance distorts relative sales in the economy. In the absence of tax avoidance ($\tau(\theta) = 1$), sales dispersion in the economy is entirely driven by differences in productivity. Instead, an increase in tax aggressiveness by one firm with respect to another leads to an increase in its relative sales. We now examine under which conditions such changes in tax aggressiveness increase concentration.

From tax avoidance to concentration. 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 shares increases relative to all firms, which reduces the CR4.

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 ($\mathcal{S}_i > \frac{\mathcal{H}_{-i}}{1+\mathcal{H}_{-i}}$).

Oligopoly pricing. The closed-form results derived above rest on the assumptions of CES demand and monopolistically competitive pricing. 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, which would increase concentration as measured by the CR4 or HHI.

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 guidances on other factors that influence sales. We use detailed data from Compustat, a

[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. $t^s - t^e_i = t^s\left(\frac{\theta_i - 1}{\mathcal{M}(\mathcal{S}_\rangle)_i\frac{1-t^s\theta_i}{1-t^s}-1}\right)$. 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.

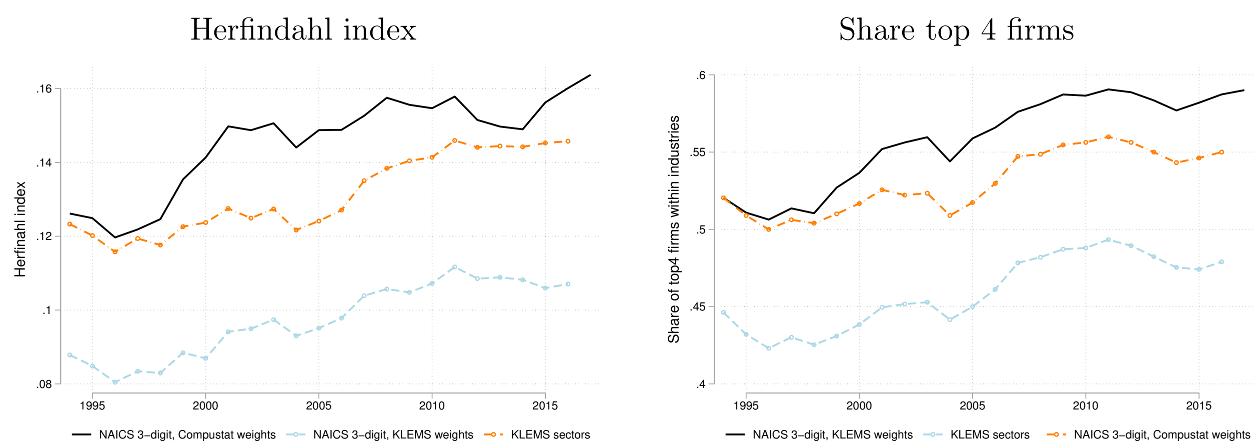
database of firm-level financial information from S&P Global Market Intelligence to construct our variables of interest. The Compustat dataset contains data consolidated at the company level. Our analysis covers the period 1994-2017 when the U.S. had a worldwide taxation system. We start in 1994 to compute a measure of long-run CTA over periods of four, six, or eight years. During 1994-2017, the profits of a U.S. company were taxed at 35%, regardless of the country where they were made. The consolidated data are therefore particularly suited to our analysis.

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 are 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, over the period 1994-2017.

3.1 Industry Concentration

In Figure 1, 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 an 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 sectors 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 either Compustat sectoral sales or KLEMS sectoral output data. The left panel of Figure 1 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 mea-

Figure 1: Evolution of concentration in the U.S. (1994-2017)



Notes: The HHI 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.

sures 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).

3.2 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). The measure has two main advantages. First, it accounts for loss years and allows us to avoid the selection bias when pre-tax income is negative, which is the case for about 38% of firm-year observations in our sample. Restricting our sample to firms with positive income and cash tax paid may thus induce some selection issues.

Second, it reduces volatility found in measures that use annual data and include tax payments of the former period (Dyreng et al., 2008; Hanlon and Heitzman, 2010). It is therefore a better predictor of long-run tax-avoidance strategy in our sample that covers 1994-2017 and is thus more informative.

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).

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). The series are summed over a long period of time s before computing the ratio. The statutory tax rate is 35% over the period of our analysis. We define Henry and Sansing's measure (HS gap) as

$$HS_{is} \equiv \frac{\sum_{t=1}^{S} (CTP_{it} - \tau \times PTI_{it})}{\sum_{t=1}^{S} BVA_{it}} \ , \tag{6}$$

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 that occurs 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. When the firm has a disfavorable tax position, the value of the cash tax paid is larger than the expected tax payment, so that 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 that 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. A legitimate concern is that this measure only captures differences in tax credits received by companies for activities such as R&D, and have little to do with tax avoidance. As we show later in section 6, our results are robust to controlling for R&D activities.

More generally, we are confident that a lower HS-gap is associated with aggressive tax-planning behaviors. Figure A.1 shows multinationals with affiliates in tax havens have a consistently lower HS-gap than other multinationals. This indirect evidence is in line with the findings of several accounting papers showing the HS-gap measures do capture aggressive tax-planning strategies of companies (see, e.g., Schwab et al., 2019; Koester et al., 2017).

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 4 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). 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 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, which is consistent with findings in Dyreng et al. (2014). 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 the smaller firms. The gap between industry leaders and other firms has also increased if one looks at the ETR, which dropped by 6 percentage points for the industry leaders and 4.6 percentage points for the others firms.

4 Corporate tax avoidance and sales

4.1 Econometric analysis

We now turn to the empirical estimation of equation (4). Firm-level sales are determined by the intensity of CTA, factors related to the productivity of the firm, 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:

$$\log s_{is} = \beta_0 + \beta_1 \log \tau_{is} + \mathbf{z}'_{is}\beta + \kappa_{k(i)s} + u_{is} \ . \tag{7}$$

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 amounts to examining the impact of past tax avoidance 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.3).

We follow Dyreng et al. (2008) by measuring tax avoidance as the ability to pay a low amount of tax for a long period of time, because reported tax and profit data may have significant year-to-year variations. We report the results using the four-years period of time and show they are qualitatively similar when using a longer period of six or eight years. 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.

The vector z_{is} describes factors that influence 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 productivity of the firm 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 been shown to influence the productivity of the firms. We add dummy-variable information on acquisitions and payout as additional left-hand-side variables. We also include a dummy variable that accounts for the firm's multinational status.

$\kappa_{k(i)s}$ 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 with respect to tax avoidance, and its perception of the legal (tax) environment. u_{iks} is the error term.

Estimation of equation (7) 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 is unclear.

Instrumentation strategy. We now present the instrumentation variable strategy (IV) used in our baseline analysis. In section 6.2, 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 each of 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.

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 are constructed using the residuals of a regression of disclosed probabilities on asset class and year fixed-effects. The mechanical correlation between the raw audit probability and firm size is therefore broken.

The residual of the audit-probability regression captures the yearly fluctuations in audit probability that are 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. As shown in Figure A.2, the residual audit probabilities are not correlated with 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 firm and period specific. We take for each firm in each year its corresponding residual audit probability that we average over the period of 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 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.[10]

Our identification strategy rests on the assumptions that tax avoidance at the level of

[10]Note the within-sector and period correlation between our instrument and the raw audit probabilities is low at about 19%.

firms responds to changes in the audit rates, and that firm size at the end of each period does 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 as well as more in-depth analysis in the accounting literature suggest changes in audit probability are explained by the underfunding of the IRS. For instance, Nessa et al. (2020) show IRS resources are positively correlated with audit probability and with the net revenue collected through tax enforcement. The reduction of the IRS enforcement budget were the results of 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.[11] Hoopes et al. (2012) argue this drop is tightly linked to cuts in the budget of the IRS and is likely exogenous to individual companies' decisions concerning tax planning. Importantly, the tax-avoidance behavior of large firms lobbying on taxation issues were not the main motivation for cuts in the funding of the IRS. As we show in section 6, a firm's participation in lobbying on taxation or on internal revenue code does not influence the effects of the residual audit probability on the level of CTA. Lobbyists have larger sales, but controlling for the lobbying status of firms does not affect the impacts of tax avoidance on sales.

4.2 Baseline results.

Table 2 shows the results of the OLS and 2SLS regressions. We include in each specification a set of sector- and period-specific effects to control for unobserved characteristics. We therefore identify the effect of each covariate using the variation in firm-level attributes across firms within sector and period. We also include firm fixed effects in some specifications. In

[11] 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 dispute during this era.

this case, we use the variation of firm-level characteristics within firm to identify the effect of tax avoidance and other covariates.

We report robust standard errors in all specifications and the Kleibergen-Paap F-tests when using 2SLS regressions.[12] The statistics yield values larger than 10 in the model that uses sector×period-specific effects and the ones that include firm-specific effects. These findings suggest the regression estimator is unlikely to suffer from weak-instruments bias.

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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

In column (1), we report the OLS results that include sector and period fixed effects. We find a negative impact of the HS_{is} measure on firm-level sales, which suggests a positive

[12] The sampling and assignment mechanisms are not clustered in our setting. We thus follow Abadie et al. (2017), 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).

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. These findings support the results of Crouzet and Eberly (2019) and Autor et al. (2020) that industry leaders are often firms that are 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 the inclusion of firm-specific 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), who show U.S. firms undertake less aggressive tax positions when tax enforcement is stricter. This finding suggests our measure of tax avoidance captures more than legal tax breaks such as loopholes, deductions, exemptions, or tax credits.

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 sector and period. The large value of the Kleibergen-Paap F-statistic (KP F-stat) confirms the strength of our instrument.

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 the reduction in the IRS audit probability significantly increases firm-level tax avoidance. Column (6) confirms the causal and positive impact of tax avoidance on firm-level sales. The effect is similar in magnitude to the one in column (4).

These results are robust to a variety of checks including controlling for potential confounding factors such as lobbying or R&D investment, alternative measures of our key variables, and an alternative IV strategy. We present these results in section 6. We now explore the implication of the impact of tax avoidance on sales for the concentration of U.S. industries.

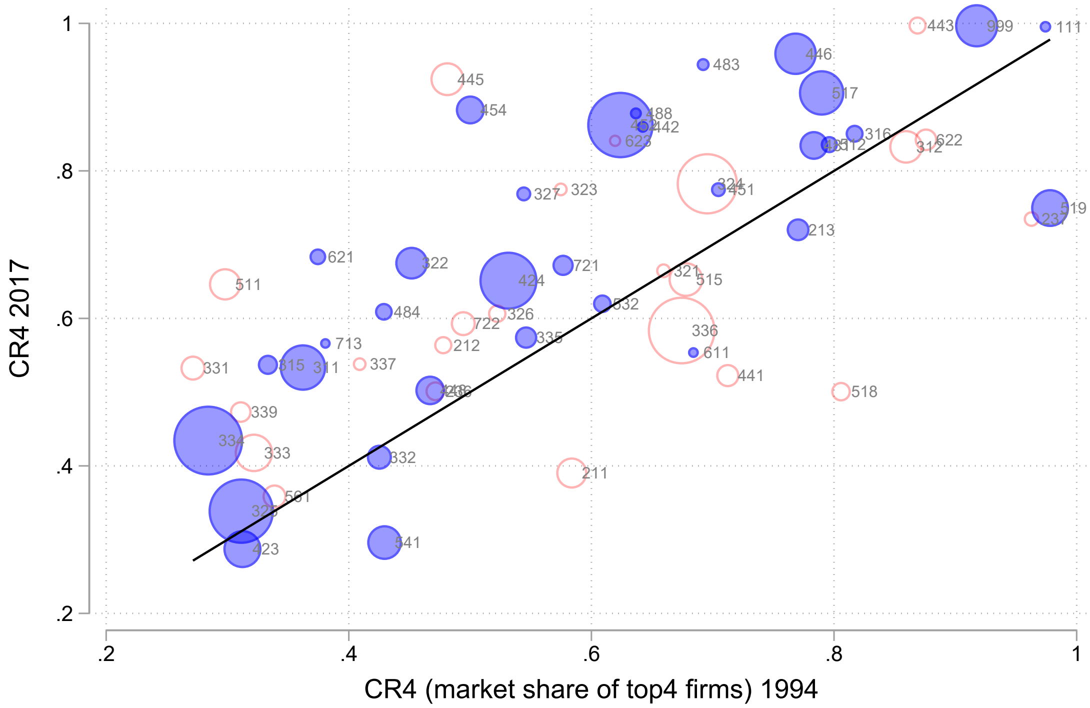
5 Tax avoidance, industry concentration, and real output

The empirical analysis shows aggressive tax planning increases firm-level sales. As shown in section 2, CTA leads to an increase in concentration as long as large firms increase tax avoidance more than smaller ones. We first show CTA did increase more for large firms than small firms in most industries, contributing to the increase in concentration. We then quantify the contribution of CTA to industry concentration.

5.1 Industry concentration and relative tax avoidance

We focus on the CR4, the market share of the four largest firms within an industry. In Figure 2, we show the CR4 for U.S. industries in 1994 and 2017. We report the evolution of the CR4 among the 50 NAICS 3-digit industries for which we have more than eight firms per year in Compustat. We see the majority of industries are above the 45-degree line, which means the share of the four largest firms has increased over the period. The size of the circles is proportional to the weight of industries in terms of sales. As Figure 2 shows, the increase in concentration is particularly prevalent among the largest sectors of the economy such as chemical manufacturing (NAICS 325), computer and electronic products (NAICS 334), general merchandise stores (NAICS 452), and telecommunication (NAICS 517). A notable exception among large industries is the transport equipment industry (NAICS 336), which experiences a drop in concentration over the period.

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



Notes: Each circle is a NAICS 3-digit industry. The size of the circle is proportional to the weight of the industry in the economy. Blue circles are industries in which tax avoidance of the four largest firms has increased relative to small firms. Hollow circles are sectors in which tax avoidance of the four largest firms has decreased relative to small firms.

The figure allows us to visualize patterns of tax avoidance across industries. Blue represents industries in which tax avoidance of the four largest firms has increased relative to smaller firms. Hollow circles depict industries in which the smallest firms experience an increase in their tax avoidance relative to larger firms. Our model suggests an increase (a decrease) in the relative tax avoidance of large firms should foster (reduce) industry concentration. Figure 2 shows 31 out of 50 industries match these predictions. They account for 73% of aggregate sales. The pattern is particularly relevant among large industries in which both concentration and the relative tax avoidance of their leaders increased.

These facts suggest the evolution of CTA is consistent with the evolution of industry concentration. We now assess its quantitative relevance.

5.2 Counterfactual level of concentration

What would be the level of industry concentration in 1994 if firms resorted to their CTA strategy of 2017? Answering this question is a way to single out the contribution of CTA to the 1994-2017 change in 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. 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:

$$\begin{aligned} \hat{s}_i &= \frac{\tau(\hat{\theta}_i)}{\tau(\theta_i)} \times \frac{\hat{\kappa}}{\kappa} \times s_i \\ \Leftrightarrow \frac{\hat{s}_i}{\sum_j \hat{s}_j} &= \frac{\tau(\hat{\theta}_i)/\tau(\theta_i) \times s_i}{\sum_j \tau(\hat{\theta}_j)/\tau(\theta_j) \times s_j}. \end{aligned} \tag{8}$$

Note the market share of firm i in equation (8) does not depend on the price index. It only depends on s_i, the aggregate sale of the four largest firms in each industry, and s_j, the aggregate sales of other firms, which are observed in the data. We use expression (8) to compute the counterfactual levels of CR4 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 concentration measured by the CR4 in 1994 if firms had followed their CTA strategy of 2017.

Results. We compute the observed and counterfactual concentration ratios as well as their evolutions between 1994 and 2017. 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 5 p.p. These figures imply that, for the average industry, about 6% of the increase in concentration can be explained by the relative increase of tax avoidance by the four largest firms. This average, however, masks a substantial heterogeneity across sectors.

Table 3 shows the results of the counterfactual analysis for each industry. For the sake of space, we display the results for industries composed of more than eight firms and whose weight in the U.S. economy is larger than or equal to 1%.

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.

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. Bauch 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.[13]

Of course, tax avoidance is not the only ingredient that contributed 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 ratio of predicted versus observed change in the

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

CR4 for these industries ranges from 2% to 28%, 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, the relative decline in CTA by large firms pushed concentration down, and observed concentration decreased as well. This pattern is observed in the industry of transportation equipment manufacturing, 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 beverages stores is another example of industry in which tax avoidance seems to have played no role in the huge increase in concentration. The absence of role of tax avoidance is not surprising in such a sector in which both large and small firms operate in the U.S., which limits their ability to avoid taxes.

5.3 The impact of CTA on real production

We now ask whether the movement in concentration induced by CTA can have an economically significant impact on real production.

The model used through the analysis draws a link between production, firms' productivity, and CTA. In our setting, we show in Appendix A.1 that real production is given by:

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

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).

Tax avoidance, however, is only one of the many sources of sales distortion in the economy.

Table 3: Evolution of observed and counterfactual industry concentration.

NAICS	Indus. weight	Observed $CR4_{17}$	$CR4_{94}$	$\widehat{CR4}$	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.

Therefore, a reduction in tax avoidance can both decrease or increase real output. Concretely, large firms in 1994 might have been producing more than what would be predicted by their productivities. 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 productivities. 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 of distortions at play. We derive 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 be equal to 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:

$$\frac{Y'}{\mathcal{P}'} / \frac{Y}{\mathcal{P}} \in \left[\left(\frac{\mathcal{S}'}{\mathcal{S}} \right)^{\frac{\sigma}{\sigma-1}} ; \left(\frac{1-\mathcal{S}'}{1-\mathcal{S}} \right)^{\frac{\sigma}{\sigma-1}} \right] . \tag{9}$$

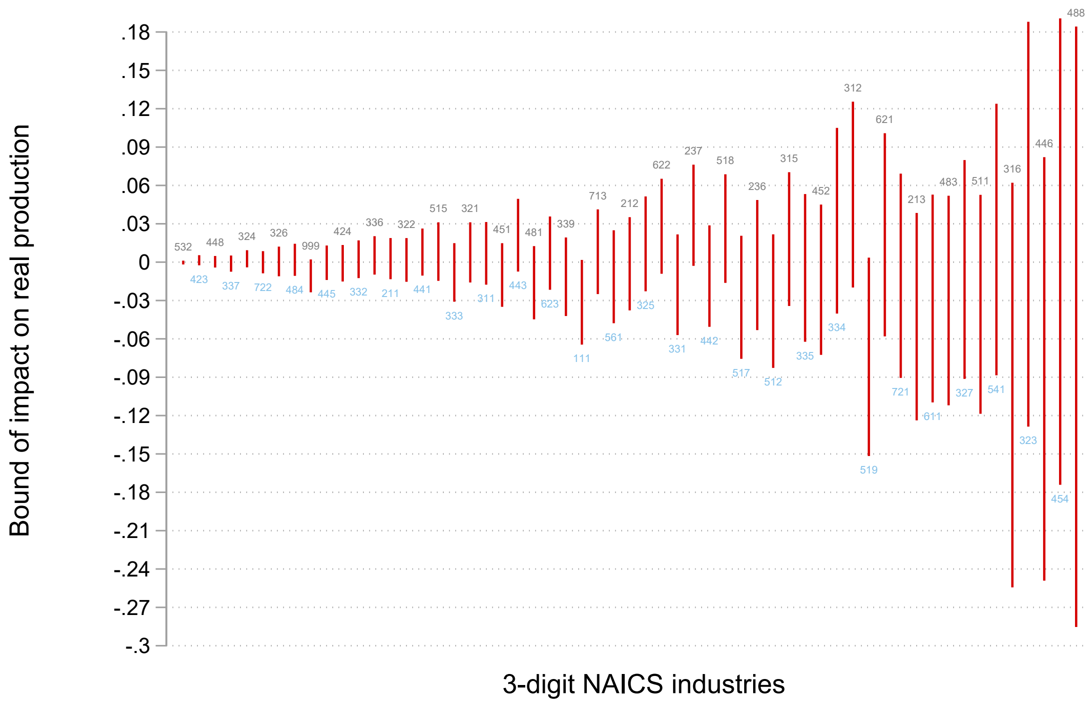
$\mathcal{S}'$ denotes the counterfactual market shares of the four largest firms in 1994 as if they had a tax-avoidance level of 2017. Y' and $\mathcal{P}'$ are the counterfactual values of sector-level output and price index, respectively. These bounds are conservative intervals of the impact of tax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

We use equation (9) 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 3. 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.

Figure 3: 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 9, calibrating $\sigma = 2$. Reading: for NAICS sector 212, the change in CTA could change real production from -3% to 3%.

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, which are industries 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 industry of transportation equipment manufacturing in which 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 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.[14] Policywise, we conclude that, beyond the increase in corporate tax revenue, curbing tax avoidance can induce a substantial change in allocative efficiency.

6 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 the use of an alternative identification strategy.

6.1 Sensitivity analysis

We discuss the sensitivity of our results about tax avoidance and sales to changes in the construction of the main variables, their robustness to the inclusion of potential confounding factors, and their stability across sectors and across firms.

Firm size and lobbying activities. Arayavechkit et al. (2018) show firm size and effective tax rate are positively correlated with their lobbying activities. We thus verify that our results are not biased by this potential confounding factor. 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 to lobbying on taxation or internal revenue code. More specifically, we are able to 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 the years 1999-2017, the sample reduces to 5,809 firms, 11.5% of which participate in lobbying activities in the last six-years period of our estimation sample. Tables A.2 and Table A.3 report the results. The

[14]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.

first two columns of Table A.2 show the results with this subsample are similar than our baseline results. We then include the lobby indicator variable in the specifications to control for 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 the inclusion of 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, the inclusion of 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 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 A.3.

HS gap, R&D tax credits, and corporate tax avoidance. The question of whether our measure of tax avoidance only captures R&D tax credits, which would lead to a different interpretation of our findings, is also legitimate. Information on R&D expenditures is missing for about 40% of 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 five period, because the effects of R&D on firm-level sales may not be contemporaneous.[15] The results reported in Table A.4 show the positive impact of tax avoidance on sales is robust to the inclusion of R&D.

Alternative time windows. We construct the HS gap by aggregating its components over six periods of four years. We show in Table A.1 that our findings hold when we use a six- or eight-year window. Note the effects have the correct signs but turn out to be insignificant in the specifications that include firm-fixed effects. This observation is expected because our identifications rely on three or four periods using these alternative time windows. In the

[15] 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.

Online Appendix (Table OA.2), we also report the results using long difference on a sample of firms that have positive sales in both the first and the last period of our sample. The OLS and 2SLS results confirm the positive impact of tax avoidance on sales over the long period.

Alternative variables. We show our findings are not driven by the scalar chosen in the construction of the HS indicator. In the baseline, we scale the difference between the amount of 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 A.1, are similar to the baseline regressions. In the third panel of Table A.1, 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 the Online Appendix (Table OA.3) 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.

Heterogeneity across sectors and firms. We analyze the heterogeneity in the impact of tax avoidance on sales across sectors and across firms. The positive impact of tax avoidance on sales is pervasive in both the manufacturing and services industries. We then interact the HS measure of tax avoidance with firm-level attributes. The impact of tax avoidance on sales is magnified for high-productivity firms. The effect of tax avoidance is also larger in firms that increased their share of intangible assets. This interaction suggests another channel through which the increase in intangibles among a few firms could affect the distribution of sales in the economy (Crouzet and Eberly, 2019). Last, we restrict the sample to firms whose headquarters is not in Delaware (a state known for having a favorable tax regime), and show our results are not driven by firms located in Delaware. These results can be found in Tables OA.4, OA.5, and OA.6 of the Online Appendix.

Markups. Our model suggests tax avoidance leads to higher sales but not higher markups. Consistent with this prediction, we show in Table OA.7 that CTA has no significant impact on firm-level markups, whether we identify its effect using the variation across or within firms within sector and period.[16]

6.2 SFAS No. 131 – A quasi-experiment

We now show the robustness of the causal impact of tax avoidance on sales to an alternative identification strategy. This alternative strategy exploits the change in the reporting requirement of U.S. publicly listed firms that occurred in 1998.

Prior to December 1998 and the implementation of the Statement of Financial Accounting Standards No. 131 (SFAS 131), all public firms were required to disclose geographic earnings, sales, and assets. After the implementation of SFAS 131, the financial-reporting requirement to disclose geographic earnings by jurisdiction is no longer mandatory. The identification strategy relies on the comparison of tax avoidance and sales before and after the change in legislation, for firms exposed to the policy versus firms that are not.The voluntary disclosure of geographic earnings by jurisdiction under SFAS 131 is likely to affect firms' tax-planning strategy, because they can conceal tax avoidance behavior (Herrmann and Thomas, 2000; Hope et al., 2013; Sullivan, 2004).

We use the implementation of SFAS 131 as an exogenous treatment affecting firms' tax-avoidance behavior. Hope et al. (2013) and Herrmann and Thomas (2000) report that most multinational firms after 1998 have chosen to no longer disclose geographic earning information. Furthermore, firms with foreign activities have been the most affected by this change. Hope et al. (2013) report that "non-disclosure of geographic earnings is not associated with differences in domestic effective tax rates but is associated with lower foreign effective tax rates", confirming the reform affected firms with foreign operations. We thus posit that multinational firms are the group of treated firms. We consider the sales and tax avoidance

[16] We construct markups following the baseline procedure proposed by De Loecker et al. (2020). The details of the analysis can be found in section OA.3).

of U.S. listed firms over six-year periods before and after the implementation of SFAS 131.

We use this experiment in two ways. First, we estimate a standard difference-in-differences 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 post-SFAS 131 period. We expect the interaction term to have a positive impact on sales, because the disclosure of geographic earnings is not required after the implementation of SFAS 131. The coefficient of the $Post - SFAS131$ 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. Indeed, Hope et al. (2013) show the change from mandatory to voluntary disclosure of geographic earnings in accordance with SFAS 131 led to increased tax avoidance for non-disclosing firms.

Table 4 presents the results of our alternative strategy using both difference-in-differences and 2SLS estimations.

Each specification includes sector and year fixed effects. We also include firm fixed effects in the specifications shown in the last three columns. The difference-in-differences strategy consists of comparing the sales of multinational firms (the treated group) with the sales of domestic firms (the control group), before and after the implementation of SFAS131. 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 experienced an increase in their 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, we find negative and significant interaction coefficients, which confirms that multinational firms significantly increased their level of tax avoidance after SFAS 131. The second-stage results show a negative and significant impact of the instrumented measure of tax avoidance on sales. These results confirm the causal impact of tax avoidance on sales.

Table 4: Sales and tax avoidance – The SFAS 131 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			-4.583***			-7.288***
			(0.920)			(2.487)
Share of Intangible	1.712***	-0.030**	1.577***	1.243***	-0.040	0.948***
	(0.129)	(0.013)	(0.124)	(0.195)	(0.027)	(0.262)
Labor Prod.	0.941***	-0.063***	0.652***	0.543***	-0.035***	0.287**
	(0.026)	(0.004)	(0.062)	(0.056)	(0.008)	(0.112)
Acquisition	1.130***	-0.024***	1.020***	0.292***	-0.010***	0.218***
	(0.038)	(0.004)	(0.042)	(0.032)	(0.003)	(0.045)
MNE Status	1.352***	-0.014***	1.290***			
	(0.047)	(0.002)	(0.053)			
MNE × $Post - SFAS131$	0.337***	-0.074***		0.121***	-0.017***	
	(0.071)	(0.007)		(0.037)	(0.004)	
Sector × Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes
Obs.	11,978	11,978	11,978	7,434	7,434	7,434
Adj. R^2	0.470	0.185		0.914	0.462	
KP F-stat.			100.7			18.03

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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

7 Conclusion

We show the relative increase in tax avoidance by large corporations has contributed to the increase in concentration observed in the data since the 1990s. The positive trends in concentration and in tax avoidance have been documented separately so far. We present causal evidence on the link between tax avoidance and firm-level sales. We find tax avoidance gives large firms a competitive edge, which allows them to increases their sales relative to smaller firms. Large firms' competitive advantage is partly explained by laxer tax enforcement, which has been favorable for larger firms in the U.S. since 1990.

We then show the trends in tax avoidance between 1994 and 2017 explain a non-negligible part of the increase in industry concentration in the U.S. In sectors such as chemical manufacturing, non-store retailers, or computer products, the increase in tax avoidance of large relative to small firms could explain from 10% to 30% of the increase in industry concentration. Furthermore, the distortions in market shares induced by CTA have the potential to influence real production in a quantitatively meaningful way in many industries.

One important insight from our analysis is that, beyond its impact on government revenues, CTA influences the allocation of activities within industries.

The analysis also highlights that (the enforcement of) corporate tax policy can curb concentration. This finding suggests competition policy may become less effective in the absence of coordinated tax policies, and that tax and competition policy are intertwined.

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Appendices

A Appendix

A.1 Theory

A.1.1 Micro-founding tax avoidance

This appendix presents three alternative micro-foundations for the β_i parameter introduced in section 2.

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 there at almost no cost. Firm profits then read:

$$\pi_i \;=\; (1-t^s)\left(p_i - p^I - \varphi_i^{-1}\right) q_i(p_i) + p^I q_i(p_i)(1-t^H)\;. \tag{10}$$

Simplifying, we get

$$\pi_i \;=\; \left(p_i - \varphi_i^{-1}\right) q_i(p_i) - t^s\left(p_i - \varphi_i^{-1}\theta_i\right) q_i(p_i)\;, \tag{11}$$

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, $\theta(\varphi)$ is increasing with firm productivity so that large firms deviate more from the arm's-length price than small firms do. 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), the sole factor of production is capital. Technology is linear and capital productivity is equal to φ. One affiliate located in a tax haven may lend for free to the parent firm located 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:

$$\pi_i = (1-t^s)\left(p_i - \varphi_i^{-1}\right) q_i + t^s b_i \varphi_i^{-1} q_i - t^H b_i \varphi_i^{-1} q_i\;, \tag{12}$$

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 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

Concentration is defined by the Herfindahl index 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 the sake of clarity.

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

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

which can be rearranged as

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

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

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

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

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

$$\frac{Y}{\mathcal{P}} = \left(\sum_{i=1}^{N} q_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \tag{13}$$

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

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

and thus

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

Plugging the above expression of output into (13) leads to the formula given in the main text:

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

Bounds on real output Consider the special case of the real-production expression above for two firms with productivites 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 is given by

$$\frac{Y}{\mathcal{P}}/\frac{Y'}{\mathcal{P}'} = \frac{\mathcal{S}'^{\frac{\sigma}{\sigma-1}} + (\varphi_i/\varphi_j)\,(1-\mathcal{S}')^{\frac{\sigma}{\sigma-1}}}{\mathcal{S}^{\frac{\sigma}{\sigma-1}} + (\varphi_i/\varphi_j)\,(1-\mathcal{S})^{\frac{\sigma}{\sigma-1}}}.$$

Evaluating this expression for $\varphi_i/\varphi_j = 0$ and $\varphi_i/\varphi_j \to \infty$ 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 the 1994-2014 period. For the tax-haven list, we follow the definition of Hines and Rice (1994) and add the Netherlands. See Souillard (2020) for a discussion of the data.

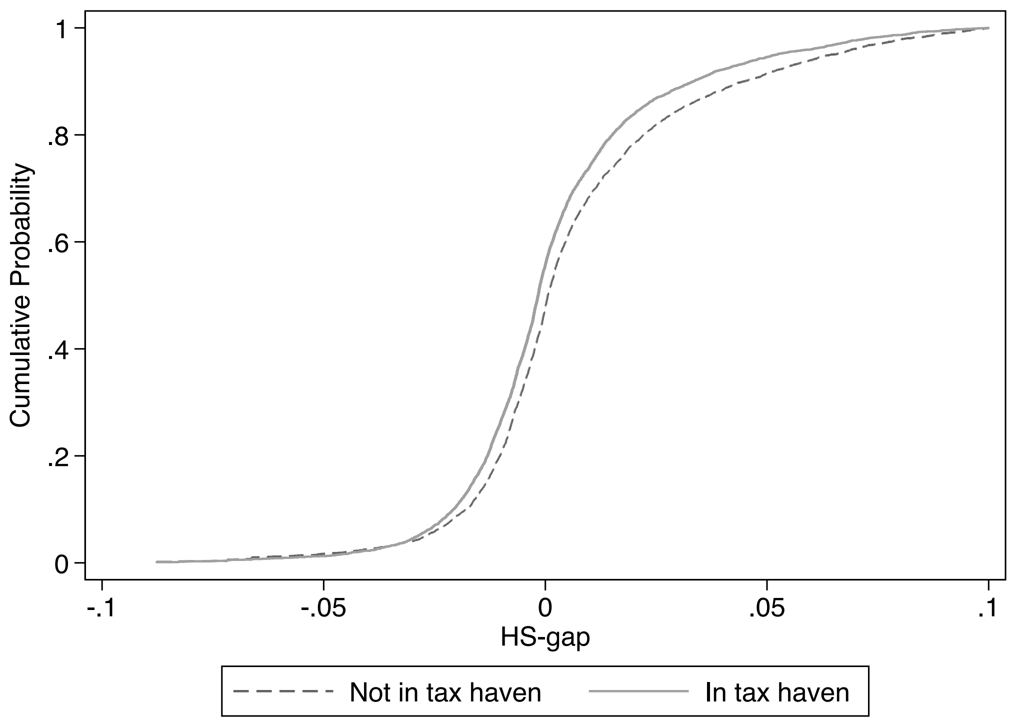
Figure A.1 shows the cumulative distribution of the HS-gap measure for the group of MNEs present in tax havens and the group of MNEs that are not. The higher of the two lines in the plot is the cumulative distribution function (cdf) of the HS-gap of multinationals that own affiliates in tax-haven countries.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

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 distribution in order 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 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 provides information on the deviations from the predicted average audit probability within each year.

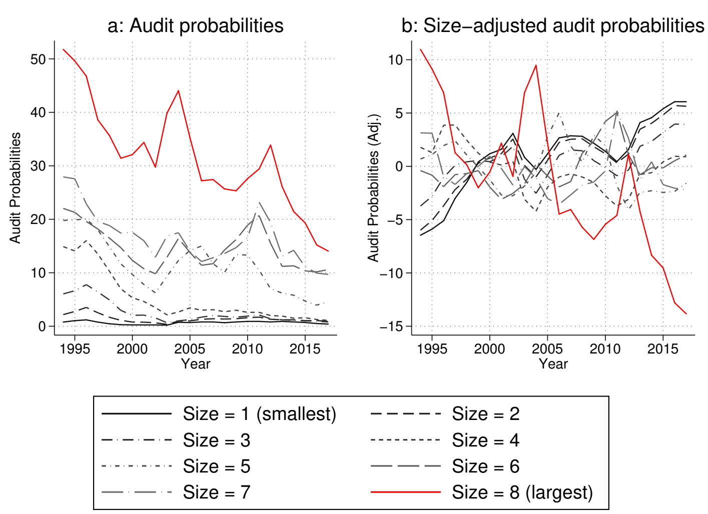
The left panel of Figure A.2 shows the evolution of the audit probabilities as computed using the raw IRS disclosed data. It shows the probability of an IRS audit has dropped for larger firms in the U.S., but remained relatively constant for the smallest firms. The drop in the audit probability for the 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 of the size-adjusted audit probabilities in the eighth class of assets from 1994 to 2017. The value

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



of assets reported by firms in this class amount to $250,000,000 or more and corresponds to the set of largest firms. The decline in the adjusted probabilities is, however, not linear across years with large variations in the early 2000 and 2010.

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



A.3 Robustness

Various windows. Table A.1 presents the results using different time windows to aggregate the component of the HS-gap measures. We also present the results using alternative definitions of our measure of corporate tax avoidance. 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 across specifications.

Table A.1: Sales and tax avoidance – Various windows

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, the 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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

Lobbying on tax issues and sales. Tables A.2 and A.3 show our main results remains when we account for firms' lobbying activities on tax issues (Table A.2) or when we reduce the sample to firms that do not lobby on tax (Table A.3).

Table A.2: 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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Table A.3: 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***
		(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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

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 firms and observations in our baseline sample. We run the initial specifications and include the intensity in R&D because 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.[17] The results reported in Table A.4 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.

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

Table A.4: 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 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

OA Online appendix (not intended for publication)

OA.1 Clustering in the firm dimension

Abadie et al. (2017) 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 firm and period as the dependent variable and our sample covers the universe of U.S. publicly listed firms. Abadie et al. (2017) 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 U.S. publicly listed firms, no such problem exisys. 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 2LS estimates with robust standard errors clustered at firm-level in parentheses. First stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

OA.2 Additional results on corporate tax avoidance and sales

Table OA.2: 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 2LS estimates with robust standard errors in parentheses. First-stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

Table OA.3: 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 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap rk 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 – 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. 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

The first-stage results confirm the adjusted audit probability remains a strong predictor of tax avoidance. Overall, the industry-specific analysis suggests 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} measure of tax avoidance with each of 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.5.

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 suggests the effect of tax avoidance is larger in multinational firms than in domestic firms.[18] Exploiting the firm variation by using firm-specific effects, we find the effect of tax avoidance is larger in firms that increased 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.6, we show our main findings hold if we exclude firms incorporated in Delaware from our analysis.

[18]Notice the interaction term between the HS-gap variable and the MNE-status indicator cannot be iden-

Table OA.5: 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)
Interacton 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, the 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 rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels respectively.

tified when using firm fixed effects.

Table OA.6: 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 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.

OA.3 Markups and tax avoidance

De Loecker et al. (2020) show aggregate markups have increased in the U.S. since 1980. They find the trend is driven by an increase in the upper tail of the markup distribution as well as an increase in the market share of high-markup firms. 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.[19] In our sample, aggregate markups have doubled over the period– a fact that is consistent with De Loecker et al. (2020).

In Table OA.7, we examine the impact of tax avoidance on markups. The specifications are similar to the one 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. This result holds whether we identify the effect of tax avoidance using the variation across or within firms and within sector and period.[20]

Indeed, if one uses the same counterfactual exercise as in the paper to compute the aggregate markups in the absence of 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 a number of large firms engaged in tax avoidance in our data do not report the highest markup in their industry. 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.

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

[20]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.7: 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 are taken at the end of the four-year window. OLS and 2LS estimates with robust standard errors in parentheses. First stage Kleibergen-Paap rk Wald F statistic reported. ***, **, and * significantly different from 0 at the 1%, 5%, and 10% confidence levels, respectively.