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Do consumers pay the corporate tax?

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Abstract

Using granular gas price data and rich variation in corporate tax rates, we find that corporate taxes increase consumer prices. About 64% of the corporate tax is borne by consumers. The effect is stronger when firms have limited access to tax planning opportunities, face stricter tax enforcement, or when consumer demand is less elastic. Taxes also reduce the number of firms and their scale, consistent with a tax-induced increase in marginal cost. Our results suggest that tax policies that increase effective corporate tax rates may have unintended consequences for consumers through higher prices.

KEYWORDS

corporate tax, tax enforcement, tax incidence, tax planning, tax policy

Les consommateurs paient-ils l'impôt sur les sociétés?

Résumé

En utilisant des données granulaires sur le prix de l'essence et des variations importantes des taux d'imposition des sociétés, nous établissons que l'impôt sur les sociétés augmente les prix à la consommation. Environ 64 % de l'impôt sur les sociétés est absorbé par les consommateurs. L'effet est plus prononcé lorsque les entreprises disposent d'un accès limité à des occasions de planification fiscale, font face à une application plus stricte des dispositions fiscales, ou quand la demande des consommateurs est moins élastique. L'impôt réduit également le nombre d'entreprises et leur taille, compte tenu de l'augmentation du coût marginal. Nos résultats portent à croire que les politiques fiscales qui ont pour effet d'accroître les taux

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effectifs d'imposition des sociétés peuvent avoir des conséquences inattendues pour les consommateurs sous forme d'augmentation des prix.

MOTS-CLÉS

application des dispositions fiscales, incidence fiscale, impôt sur les sociétés, planification fiscale, politiques fiscales

1 | INTRODUCTION

Although prior literature on tax planning examines how firms reduce tax payments using various strategies, we study whether and to what extent firms reduce their tax burden by passing on corporate taxes to consumers in the form of higher prices. Although it is of fundamental importance to understand whether corporate taxes affect consumers, the issue of the tax incidence falling on consumers is less prominent than that of tax planning in academic and public debates. For example, a common assumption by policy-makers is that the corporate tax burden is borne not by consumers but is shared by firm owners and employees (Fuest et al., 2018; Suárez Serrato & Zidar, 2016).¹ We contribute to this debate by examining to what extent consumers bear part of the corporate tax in the form of higher consumer prices and when and why this potential effect is greater or smaller.

There are different theoretical arguments explaining why higher corporate taxes can result in higher consumer prices. For example, in the classical approach (Fuest et al., 2018; Harberger, 1962), consumers face higher prices because taxes reduce corporate investment and output, leading to downscaling at firm and industry levels (Djankov et al., 2010; Giroud & Rauh, 2019) and driving firms out of the market (Brekke et al., 2017). This effect is greater when firms face tax deductibility limits on certain costs (e.g., the cost of equity financing) and taxes effectively increase their marginal cost.² Even absent investment and output changes, taxes can increase prices if firms treat them as an additional cost, increasing their cost base or decreasing residual consumption income. This mechanism may be present when business owners are less sophisticated—for example, when they apply heuristics, such as a target markup, instead of maximizing after-tax profits (Ablett & Hart, 2005). Collectively, these arguments predict that higher corporate taxes increase consumer prices. However, the extent to which consumers bear the corporate tax burden is *ex ante* unclear because this extent is a function of the relative elasticities of supply versus demand (Weyl & Fabinger, 2013) and tax planning opportunities (Dyreng et al., 2022).

We test these predictions in the setting of Germany's retail gasoline market, where rich local tax rate variation and granular price data are available. First, each municipality in Germany can set its own tax rate on business profits, the so-called local business tax rate. Tax rates range between 7% and 19.25% and are thus economically meaningful and salient relative to the 15% federal corporate tax rate. We can isolate the effect of taxing business profits on consumer prices because other relevant taxes do not vary across firms, and because tax rates do not change in response to business cycle shocks (Foremny & Riedel, 2014; Fuest et al., 2018). Second, in the setting of the German gasoline market, we observe high-quality granular price data for about 15,000 gas stations selling a homogeneous commodity. Third, the setting allows us to examine differences not only in market power but also in tax planning opportunities (e.g., via tax enforcement) and tax shields across firms to provide novel evidence on the extent to which firms with low tax

¹For example, the Congressional Budget Office and the Joint Committee on Taxation assign 25% of the corporate income tax burden to labor and the rest to capital (see <https://crsreports.congress.gov/product/pdf/IF/IF10742>).

²For a pure profit tax with full deductibility, the incidence fully falls on firm owners (Fuest et al., 2018). Similarly, taxes might not be passed on to consumers if demand is (almost) perfectly elastic.

planning opportunities and/or less elastic consumers pass on more of the tax to consumers (as predicted in Dyreng et al., 2022). Finally, although gas stations are small entities, most are directly or indirectly linked to a small number of major oil companies, which influence and plausibly result in fairly sophisticated business decisions of individual gas stations (e.g., pricing or tax planning).

Empirically, we employ a staggered difference-in-differences (DiD) approach. We examine how gas prices at the gas station level in a municipality respond to tax rate changes relative to the gas price trend of gas stations from nearby municipalities without tax rate changes. Since our final sample comprises 4,474 municipalities (the level at which the tax rate varies) belonging to about 400 districts with an average area of 471 square miles, gas stations experiencing tax rate changes and counterfactual gas stations are exposed to similar variation in local economic conditions. We also control for time-varying municipality characteristics (e.g., unemployment rate, number of cars per inhabitant, and local budget deficits) to account for differences in input prices and demand.

We find that a one percentage point increase in the local business tax rate raises gas prices, on average, by 0.1 euro cent per liter. Although this appears small relative to the average gas price of 1.39 euros per liter (around 5.15 dollars per gallon) of E5 (gasoline with 5% ethanol) during our sample period, it is important to note that roughly 90% of the retail gas price is fixed and margins are thin. Because we observe only prices and not quantities sold, it is difficult to translate this estimate into a percentage of the tax borne by consumers. However, our back-of-the-envelope estimate suggests that about 64% of the corporate tax, a substantial amount given the average local business tax burden of 14%, is borne by consumers, with our main estimates ranging between 61% and 72%. This magnitude is higher than the 31% in S. R. Baker et al. (2021), who study corporate tax-induced price increases in a broader basket of goods, but comparable in magnitude to sales tax-induced price increases of 40% to 81% in Montag et al. (2020). We also show that the effect persists over several years and that the effect is likely asymmetric. Although tax increases are passed on to consumers via higher prices, the few decreases we observe in our sample suggest they do not result in lower prices. However, we acknowledge that the latter result may suffer from a lack of power.

Our main result is robust to the inclusion or exclusion of controls, using a first-difference specification, splitting the effect by year, excluding municipalities that are never treated, and comparing municipalities with one tax change to those with no tax changes. These tests address concerns about staggered DiD design raised in recent literature (A. Baker et al., 2022; Barrios, 2021; Goodman-Bacon, 2021). Consistent with the parallel trends' assumption, we find that prices do not respond to future tax changes. To sharpen the causal interpretation of our findings that corporate taxes are shifted to consumers, we replicate our results by exploiting a feature of the German tax code that introduces a discontinuity in the extent to which gas stations, depending on their legal form and the tax rate, are affected by changes in local business tax rates.

Next, we explore the heterogeneity in the extent to which local business taxes result in higher prices. We examine two dimensions. First, we explore differences in company access to strategies that reduce the tax burden. The theoretical prediction is that better access to tax planning opportunities considerably reduces the degree to which the tax incidence falls on stakeholders (Dyreng et al., 2022; Fuest et al., 2018). To investigate the potential substitution between the tax incidence falling on consumers and tax planning opportunities, we use two different measures. First, we examine differences in access to local tax advisors to facilitate tax planning (Zwick, 2021). Second, we exploit differences in tax enforcement across the 16 German federal states. Since tax enforcement limits tax avoidance (Hoopes et al., 2012), we expect to find a higher tax incidence for consumers under stricter tax enforcement. In line with a substitutive relation between tax planning and tax incidence (Fuest et al., 2018), we find that prices respond more to taxes when gas stations have limited tax planning opportunities. The results indicate that consumers bear almost all (none) of the tax burden when tax planning opportunities are muted (greater) or tax enforcement is stronger (weaker). Moreover, we exploit variation in the extent to which gas stations use debt vis-

à-vis equity financing. Because the cost of debt (equity) financing is (not) deductible, we predict and find a muted tax incidence falling on consumers for firms using more debt capital because of tax shields. These findings imply that access to other ways to reduce the tax burden (e.g., tax shields or tax avoidance, as in Graham & Tucker, 2006) results in lower consumer tax incidence.

As a second dimension of heterogeneity in the extent to which taxes result in higher prices, we examine whether the relative elasticity of demand vis-à-vis supply explains differences in the strength of the tax incidence. Since demand elasticity is closely related to market power (Lerner, 1934), we exploit differences in several related gas station characteristics—for example, gas stations open at night or located in municipalities bordering countries with systematically lower gas prices. We find that gas prices respond considerably more to business taxes for gas stations facing less intense local competition and less elastic consumer demand. In these tests, we find that consumers bear almost all of the tax burden when consumer demand is relatively inelastic and local competition is not intense. To address concerns about the generalizability of our findings based on one product, gasoline, we exploit the fact that most gas stations also sell diesel, which plausibly has more elastic consumer demand—for example, a large bulk of diesel demand comes from drivers of business vehicles and other frequent drivers, who more actively choose gas stations based on prices. We find that the passing on of taxes is stronger for products with less elastic demand, consistent with the notion that price response depends on the relative demand elasticity.

In a final step, we shed light on other real effects that would be consistent with the theories underlying the tax effect on prices. We find that taxes reduce gas stations' investment and that firms may exit the market because of higher taxes. These results suggest that the documented price increase due to taxes is at least partly rooted in the adverse effects of higher taxes on the number of firms in a market and their size through an increase in firms' marginal cost. These results are consistent with the classical approach and the investment response to taxes in Djankov et al. (2010), Zwick and Mahon (2017), Giroud and Rauh (2019), and the prediction in Brekke et al. (2017). However, we note that we lack data to isolate this explanation from others fully—for example, price increases being rooted in markup pricing (Ablett & Hart, 2005), which can lead to similar effects.

Our findings contribute to the literature in two ways. First, our paper adds to the literature on corporate tax incidence (Fullerton & Metcalf, 2002). Our setting allows us to provide evidence quantifying the share of the tax burden borne by consumers as opposed to prior literature studying shareholders or workers (Fuest et al., 2018; Suárez Serrato & Zidar, 2016). Our estimates suggest that between 61% and 72% of the corporate tax burden is passed on to consumers in the form of higher prices. Our findings also suggest that, while the effect of taxes on prices persists, the effect is asymmetric: Tax hikes increase prices, whereas tax cuts appear to leave prices unchanged (see also Benzarti et al., 2020 and the case of the value-added tax, VAT).

Second, we show that tax planning opportunities, tax enforcement, and other tax shields, as well as market power or the availability of close substitutes, shape the effect of taxes on consumer prices. Our results thereby complement contemporaneous work (S. R. Baker et al., 2021) and prior literature on taxes and consumer prices with less granular tax and price data (Ablett & Hart, 2005). The corporate tax incidence borne by consumers is lower when customers have close substitutes available, or when firms have access to tax planning. The empirical findings that greater tax planning opportunities result in lower tax incidence being passed on to consumers are novel as we use price data to test the theoretical predictions in Slemrod and Yitzhaki (2002), Fuest et al. (2018), or Dyreng et al. (2022). Given the substitutive relation between the tax incidence falling on consumers and tax planning opportunities, our findings add to the literature on the relation between tax planning and tax enforcement (Hoopes et al., 2012), tax base characteristics (Buettner et al., 2012; Voget, 2011), and debt tax shields (Graham & Tucker, 2006).

Finally, our paper has policy implications. In contrast to assumptions made by policy-makers—for example, the Joint Committee on Taxation assigns 25% of the corporate income tax burden to labor and the rest to firm owners—we find that consumers are an important missing piece in the equation, sharing the corporate tax burden. Bearing in mind that tax revenues fund public goods that provide benefits to individuals, our findings imply that policies that increase the corporate tax burden may also affect consumers via higher prices, while tax decreases do not necessarily lead to price decreases. Our findings also highlight the important role of tax system features under the control of policy-makers, such as the definition of the tax base, for tax incidence.

However, several caveats and limitations are in order when interpreting the implications of our results. Our inferences are based on the German retail gasoline market, which might be considered peculiar because demand is relatively inelastic and there is a minimum wage for labor. Hence, more research is needed to cover broader samples of firms and industries. Although we have access to granular price data, we also face data limitations as gas station-specific profitability and investments are not observable. However, our results can inform other settings because gasoline is comparable to many other products, especially those related to nondiscretionary spending. Nondiscretionary spending amounts to around two-thirds of a household's budget (Gooding, 2011, 2017; Schanzenbach et al., 2016). Second, the economic mechanisms—for example, differences in tax planning opportunities or in the relative elasticity of supply and demand—are plausibly also at work for other goods, albeit with different magnitudes.

2 | THEORY, PRIOR LITERATURE, AND INSTITUTIONAL BACKGROUND

2.1 | Theory and prior literature on corporate tax incidence falling on consumers

Theory suggests that corporate tax increases can lead to reduced company profits, higher prices for consumers, declines in wages for workers, lower incomes for shareholders, or a combination of these effects (Auerbach, 2006; Fuest et al., 2018). In the product market, Weyl and Fabinger (2013) show that one key principle is that the pass-through rate at which taxes are passed on to consumers—that is, the tax incidence falling on consumers—is determined by the relative elasticity of consumer demand and supply. Importantly, this key principle, where incidence is higher if consumer demand is relatively less elastic, is valid for different market structures—namely, monopoly, oligopoly, and imperfectly or perfectly competitive markets. The second key factor determining tax incidence is access to tax planning opportunities as an alternative means to reduce the tax burden (Dyreng et al., 2022; Fuest et al., 2018), which can reduce the tax incidence on consumers.

There are two primary channels through which corporate taxes affect prices. First, when taxes increase the effective marginal cost of labor or capital, profit-maximizing output and investments are reduced. This downscaling occurs primarily at the firm level, but also—for example, when marginally profitable firms cease to operate—at the industry level. This channel is likely to operate when firms face limits on the deductibility of their costs (Brekke et al., 2017). In addition, the higher marginal cost must be relevant because firms adjust to taxes (e.g., in the short to medium term, Gruber, 2022).

Second, even when output and investment are unchanged, higher taxes can directly raise prices if firms simply treat taxation as an additional cost that increases their cost base and decreases residual income. If firms use their cost base in some form of markup pricing, both prices and wage negotiations can be affected by tax hikes—for example, when firms use heuristics, such as a target markup, as opposed to maximizing after-tax profits (Ablett & Hart, 2005).

Although the markup-based explanation appears plausible in a gas station setting, it is empirically challenging to discriminate between these explanations. However, we provide some evidence in Section 6 that at least part of the incidence results may be due to downscaling at the firm or industry level.

Prior estimates for the (corporate) tax incidence falling on consumers are scarce. Ablett and Hart (2005) and S. R. Baker et al. (2021) report that consumers bear about a third of a corporate tax increase. A related study on sales taxes shows that around 50% of the sales tax on gas is passed on to consumers in Germany, with estimates varying according to the elasticity of demand (Montag et al., 2020). Importantly, most of these estimates are conditional on particular markets (more versus less competitive product markets) and on assumptions that are restrictive, often owing to the unavailability of data (e.g., on factor inputs). We contribute relative to these papers by using a clean empirical setting to extract the economic magnitude of the share of taxes borne by consumers and the conditions under which this pass-through is larger or smaller—for example, with respect to the relative elasticity of demand or the availability of tax planning opportunities.

2.2 | Institutional background of local business tax in Germany

Our empirical strategy exploits variation in local German business taxes. These taxes vary frequently, but not in response to variations in local economic conditions (Foremny & Riedel, 2014; Fuest et al., 2018). In Germany, business taxes depend on the legal form. German corporations, like C corporations in the United States, are taxed on their profits, and shareholders are taxed upon dividends payout (at a rate of 25%). Corporate profits are subject to a federal tax of 15% and the local business tax at the municipality. There are almost 11,000 municipalities in Germany. Local taxes account for roughly 40% of their total revenues. Although the tax base of the local business tax is defined at the federal level, the municipality sets a local multiplier that results in variation in the tax rate. Unincorporated (e.g., partnership) firms' profits are passed directly to their owners to be taxed at the owner level (like the income of S corporations in the United States). These profits are subject to personal taxes with marginal tax rates of up to 45%, and to local business taxes. Owners of unincorporated firms also receive a tax credit for local business tax of up to 13.3%.³ Local business taxes exceeding that level are a true tax burden, and we exploit this peculiarity in a later test. In sum, for a local business tax of 14%, a pre-tax profit of 100, and assuming that the profit is paid out as a dividend, corporate owners obtain an after-tax income of 53.25. In contrast, owners of a partnership obtain an after-tax income of 54.30 (see Figure A.1 in Appendix S1).⁴

Local business taxes change frequently. Changes in local business tax rates are mostly politically motivated (Castanheira et al., 2012; Foremny & Riedel, 2014) and do not occur in response to local economic conditions (Fuest et al., 2018). For our sample municipalities and sample period, there were 1,583 changes in local business tax rates higher than or equal to 0.25 percentage points. Of those changes, 1,544 were increases (on average, 0.8 percentage points). Only 39 were decreases (on average, 0.7 percentage points). The sample mean change amounts to 0.66 percentage points, whereas the median and mode changes amount to 0.52 and 0.35 percentage points, respectively. The changes occurred throughout Germany among both urban and rural municipalities. Figure 1 shows all increases (A) and decreases (B) of more than 0.25

³This credit is granted by the federal government as part of the personal income tax. Moreover, if a firm operates establishments in different municipalities, the firm's total profit is allocated through formulaic apportionment using labor costs as the single factor. A firm with a 100,000 euro profit from two stations in municipalities A and B with tax rates of $\tau^A = 10.5\%$ and $\tau^B = 7\%$ and three and two employees, respectively, thus pays a local business tax of 9,100 euros ($100,000 \text{ euros} \times [10.5\% \times 3/5 + 7\% \times 2/5]$), of which 6,300 euros is paid to municipality A and 2,800 euros to municipality B. The tax credit for unincorporated firms is limited by the municipality: If municipality A has a rate above 13.3% and municipality B has a rate below 13.3%, firms get the full credit in B, but only a credit of 13.3% in A.

⁴See Appendix S1 in the Supporting Information.

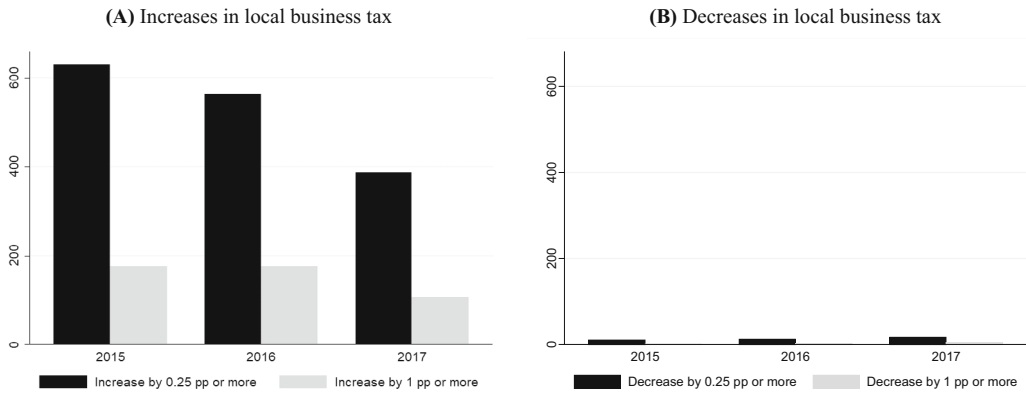


FIGURE 1 Distribution of local business tax changes. This figure shows the numbers of local business tax increases (A) and cuts (B) larger than 0.25 percentage points and one percentage point.

percentage points and of more than one percentage point. Figure 2 shows a map of our sample municipalities and the quintiles of the local business tax (A), as well as a map that indicates municipalities with changes in the local business tax (B).

2.3 | Institutional background of gas stations and prices in Germany

Our empirical strategy uses granular gas price data because these unique data are available since December 2013, when all gas stations scattered throughout the German municipalities were required by law to report every price change to an entity of the Federal Cartel Office. The price of gas comprises several elements, with the main drivers being crude oil prices, which drive ex-refinery fuel prices, and taxes and duties—for example, energy and value-added taxes, representing 47.7% and 19% of the 2017 gas price, respectively. Most sales stem from E5 gasoline (with 5% ethanol), its variant E10, and diesel. Diesel is the cheapest fuel (because of low energy taxes), followed by E10, and then E5. In 2017, the spread was 2–3 euro cents per liter between E5 and E10, and 17–24 euro cents per liter between E5 and diesel. Further cost drivers are transportation, storage, salaries, and capital expenditure (Mineralölwirtschaftsverband [MWV], 2006).

A typical gas station in our setting is under the brand affiliation and/or influence of one of a small number of major oil companies. These major companies or brands can be grouped according to market share and vertical integration. Haucap et al. (2017) and the Federal Cartel Office (2011) identify a group of major oligopolistic players that includes Aral (BP), Shell, Total, and Esso (ExxonMobil); other integrated players, like Jet (ConocoPhillips), Star (Orlen), Agip (Eni), HEM (Tamoil), and OMV; and independent players and brands such as Avia, which are often part of UNITI, the federal association of medium-sized oil companies.

Individual gas stations are either owned and operated by the major oil companies themselves or operated by other owners (e.g., as franchisees), selling gas under the brand and on behalf of the major companies (e.g., as franchisors). Anecdotal evidence suggests that budgeting and investment decisions are set jointly by the station and the oil company. Hence, the oil company often has features of an owner-manager-like residual claimant involved in and exposed to the operating performance and investing activities of the individual gas station. Importantly, there is centralized pricing steered by the oil company, but these prices vary locally due to local competitiveness, station-specific services, and amenities, and whether the fuel is sold at a brand-affiliated station (Haucap et al., 2017). Even stations that are not affiliated with major oil companies are related to them because the major companies have exclusive access to refining capacities and act as suppliers.

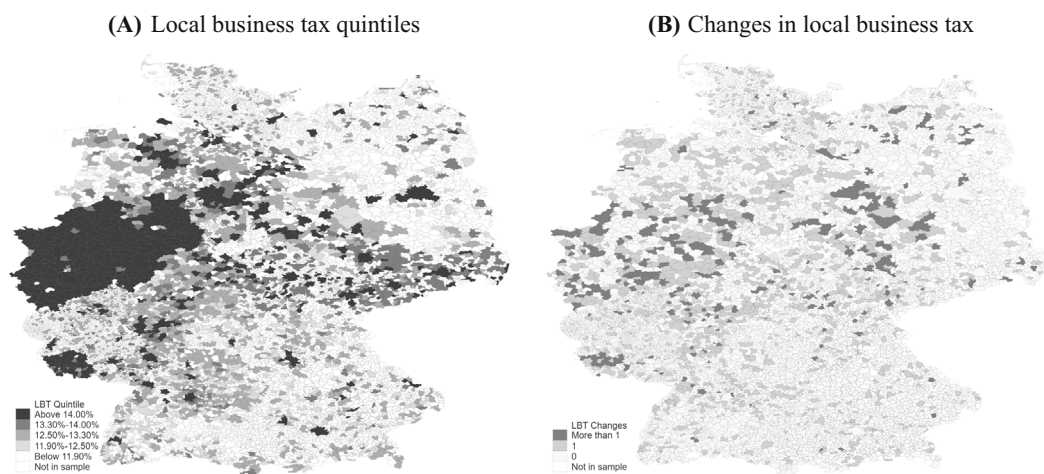


FIGURE 2 Local business tax in Germany. This figure depicts the local business tax landscape in Germany. (A) The distribution of local business tax in Germany, with the municipalities divided into quintiles. (B) Whether a municipality has experienced one or multiple changes in local business tax rates over the sample period.

These features are also evident in the gas price data. Average gas prices by station and year are normally distributed (Figure A.2, Appendix S1), but they vary within the same local region (Figure A.3, Appendix S1). Moreover, gas prices vary with local characteristics (Linder, 2018) and with brand affiliation. For example, gas stations of the same brand have related prices, but these differ across and within regions. Put differently, pricing appears to be centralized at the level of major oil companies, who then adjust prices for local variations. These features indicate a fairly high level of sophistication in gas stations' pricing and imply that both local (at individual gas stations) and central (at the oil company level) characteristics matter for prices. Moreover, the pricing of brand-owned or affiliated gas stations in a given region spills over to other gas stations in the same region (see Part B of Appendix S1). Hence, it is plausible that even less sophisticated operators of independent gas stations consider business taxes in their pricing.

It is often argued in prior literature that competition between gas stations is restricted to local market areas—for example, within a municipality or reasonable driving distance for consumers of around 20 to 30 minutes. In these local areas, the market structure varies between more competitive and oligopolistic markets (Büchel & Rusche, 2022). Overall, the demand for gas is fairly price-elastic. Ritter et al. (2016) identify price elasticities of between -0.25 and -0.87 , similar to the -0.5 reported by Frondel et al. (2012) for Germany and estimates for the United States by Coglianesi et al. (2017). In this vein, we also exploit differences in demand elasticity, which depends on the availability of close substitutes—for example, for gas stations open at night, fewer substitutes are available (but also demand might be lower).

3 | SAMPLE SELECTION, DESCRIPTIVE STATISTICS, AND RESEARCH DESIGN

3.1 | Sample selection and descriptive statistics

Our initial sample contains 15,551 gas stations. Since we require information on all regional control variables and we needed to assign gas stations to municipalities uniquely, we obtain a final sample of 14,255 gas stations and 54,261 gas station-year observations over the period

2014–2017. Our tests generally follow the principle that we use all available data for which we have coverage on our main variables. Hence, for some cross-sectional and identification tests, we can only use information on subsamples because some of the variables are not available for all firms. Table 1, Panel A, presents summary statistics for all variables. On average, for our sample period, the price of a liter of regular fuel (E5) is 1.39 euros. Thirty percent of our sample gas stations are also open at night. The local business tax rate averages 13.85% for our sample period, with an increase from 13.7% in 2014 to 14% in 2017. Table 1 also presents descriptive statistics on the 4,474 municipalities in our sample.⁵ Unemployment averages 2.5% of the total population. The median budget deficit of a municipality is about 8,000 euros per inhabitant, while the mean deficit is negative, indicating that the average municipality has a local budget surplus. In our sample, the median (average) number of inhabitants per municipality is 6,621 (16,395), and the median (average) number of registered cars is 5,050 (10,759). On average, there are about 14 gas stations per municipality.

3.2 | Baseline regression

We use a staggered DiD design to examine tax incidence falling on consumers. We compare the prices at gas stations in a municipality with a local business tax rate change to the prices at gas stations located in municipalities within the same district, where the local business tax rate did not change. Specifically, we exploit the fact that the mean number of municipalities in a district is 17, which results in the following estimation equation:

$$Gas\ Price_{i,t} = \alpha_0 + \beta_1 Tax\ Rate_{mt} + \gamma X_{mt} + \alpha_i + \alpha_d \times \alpha_t + \varepsilon_{mt}, \quad (1)$$

where, for municipality m in year t , the dependent variable is *Gas Price*, the average⁶ gas price of gas station i , and *Tax Rate* is the local business tax rate. We use the average price of E5 because it is normally distributed, and E5 is the most important type of gas in terms of sales. We note that the E5 price includes the VAT of 19%. Hence, any price change due to local business taxes reflects a price increase including the VAT. We replicate our tests using the prices of diesel or E10 (see Table A.1 in Appendix S1). The results support our main inferences.

Our main independent variable is *Tax Rate*, which is the local business tax rate (in percentage points) in municipality m in year t . If a gas station passes on the tax burden of the local business tax to consumers, β_1 is expected to be positive. We use a continuous tax measure instead of simple dummy variables for increases or decreases to be able to provide estimates of the tax incidence falling on consumers (see also Fuest et al., 2018 for the use of a continuous tax measure). We include district-year fixed effects ($\alpha_d \times \alpha_t$) and gas station-fixed effects (α_i) to ensure that our identification stems from changes in local business tax and that control gas stations are located within the same district.⁷ If tax rates never changed, gas station-fixed effects would absorb the main coefficient on *Tax Rate*; hence, only changes identify the *Tax Rate* coefficient. Since districts are rather small, treated and control gas stations are subject

⁵The mean and median populations in our sample municipalities in 2017 are 16,442 and 6,543, respectively. In the dropped municipalities, the mean (median) population is 1,232 (790). Put differently, municipalities without gas stations are very small and, thus, unlikely to host gas stations. Some municipalities were also lost because of frequent mergers between municipalities in the less densely populated parts of Germany.

⁶Our analysis is based on annual average prices because the local business tax rate is set annually. Once set by the local authorities, the tax rate is effective and persists for a full year. Therefore, prior literature on tax incidence has used annual metrics, even though higher-frequency metrics would have been available, to be consistent with the level of variation of the tax rates and many of the control variables (S. R. Baker et al., 2021; Fuest et al., 2018).

⁷With this specification, municipalities that are also districts (e.g., Berlin, Munich, Hamburg, Cologne, and Frankfurt) do not identify the coefficient. These cities contribute to the identification of *Tax Rate* only with state-year fixed effects (with the exception of Berlin and Hamburg because these municipalities are states at the same time).

TABLE 1 Descriptive statistics and correlations.

Panel A: Descriptive statistics						
Variable	Obs.	Mean	Std. dev.	25th percentile	Median	75th percentile
<i>E5</i>	54,261	139.29	8.45	133.19	137.48	145.43
<i>Tax Rate (%)</i>	54,261	13.85	1.87	12.25	13.65	15.40
<i>Affected</i> ^a	29,765	0.68	0.47	0.00	1.00	1.00
<i>Unincorporated</i> ^a	29,765	0.12	0.33	0.00	0.00	0.00
<i>Incorporated</i> ^a	29,765	0.88	0.33	1.00	1.00	1.00
<i>24/7</i> ^a	44,351	0.30	0.46	0.00	0.00	1.00
<i>High Tax Advisor Density</i>	54,261	0.51	0.50	0.00	1.00	1.00
<i>Average Debt Ratio</i> ^a	1,597	0.64	0.24	0.48	0.66	0.85
<i>Credit Limit</i> ^a	8,269	0.01	0.01	0.00	0.00	0.01
<i>Employees</i>	8,503	10.46	16.40	3.00	7.00	12.00
<i>Total Assets (in € million)</i>	1,671	0.91	2.38	0.22	0.42	0.69
<i>Revenues (in € million)</i>	5,968	7.17	23.55	1.23	3.10	8.60
<i>Exit</i>	41,316	0.48	6.94	0.00	0.00	100.00
<i>Rating Downgrade</i>	7,363	0.15	0.36	0.00	0.00	1.00
<i>Cars</i>	54,261	10.76	35.13	2.50	5.05	9.94
<i>Stations per Car</i>	54,261	0.00	0.00	0.00	0.00	0.00
<i>Unemployment Rate</i>	54,261	0.03	0.01	0.02	0.02	0.03
<i>Deficit</i>	54,261	-24.14	329.86	-127.84	8.18	130.34
<i>Property Tax</i>	54,261	428.05	106.54	360.00	400.00	480.00
<i>Population</i>	54,261	16.40	74.51	3.27	6.62	13.37
<i>Additional Revenue</i> ^a	13,904	113,396.90	54,424.28	57,783.67	117,376.30	126,701.70
<i>Tax Auditors by Office</i> ^a	19,199	51.72	3.72	50.46	52.80	53.09

Panel B: Correlations of cross-sectional variables						
	(1)	(2)	(3)	(4)	(5)	(6)
(1) <i>Affected</i>	1					
(2) <i>24/7</i>	0.07	1				
(3) <i>High TA Density</i>	-0.07	-0.03	1			
(4) <i>High Enf. Rev.</i>	0.05	-0.01	-0.00	1		
(5) <i>High Enf. Emp.</i>	0.05	-0.06	-0.00	-0.51	1	
(6) <i>High Debt</i>	-0.13	-0.03	-0.01	0.03	0.02	1
(7) <i>High Credit Limit</i>	-0.01	0.09	-0.03	-0.01	-0.05	-0.13

Note: This table presents descriptive statistics for the main variables. Panel A shows the descriptive statistics for our main variables. Panel B reports the correlation coefficients between the split variables. Nonsignificant correlations are reported in italics.

^aVariables available only for a limited sample.

to very similar local economic conditions. Gas station-fixed effects (α_i) also account for many time-invariant characteristics, such as the distance to the next gas station, which is very sticky during our sample period. Although these fixed effects ensure comparison within districts, this may come at the cost of observations that do not contribute to the identification, or that are singletons—for example, because there is no variation in the local business tax rate for a particular gas station, or because there is no variation in tax rates within a district year (de Haan, 2021). We run the summary statistics suggested by de Haan (2021) to show that, while gas station-fixed effects absorb most of the variation in *Tax Rate*, there are many

observations with variation in the local business tax rate (Table A.2, Appendix S1). We drop them in a robustness test to show that observations without variation in *Tax Rate* do not affect our findings. Each table also reports the initial number of observations and excluded singletons.

Furthermore, we add multiple controls related to variation in local economic conditions and gas demand (vector X). The controls include the number of cars, the number of gas stations per car, and the natural logarithm of the unemployment rate for municipality m in year t . One potential source of endogeneity is that municipalities can change tax rates due to financing needs. Hence, we add two controls. First, we control for a municipality's budget deficit (or surplus) per capita, winsorized at the 1st and 99th percentile. Second, we control for the local property tax, another main source of municipal funding set by municipalities. We cluster standard errors at the municipality level.

4 | TAXES AND CONSUMER PRICES

4.1 | Local German business taxes and gas prices: Main results and economic magnitude

We first examine how local business taxes relate to gas prices. Table 2, Panel A, reports the regression results from estimating Equation (1) without controls (Columns 1 and 3) and with controls (Columns 2 and 4). In Columns 1 and 2, we include district-year fixed effects to narrow down the counterfactual gas stations to those in municipalities without a tax rate change located in the same district. Columns 3 and 4 include state-year fixed effects, so that all municipalities, including bigger cities, help to identify the *Tax Rate* coefficient. The results show that the E5 price is positively and significantly affected by the local business tax rate. The coefficient of the local business tax rate is positive and statistically different from zero at the 5% level in all specifications, whether we include control variables or change counterfactuals. In terms of economic significance, the estimate in Column 2 suggests that a one percentage point increase in the local business tax rate raises the E5 price by 0.108 euro cents per liter. For smaller increases in the local business tax, such as the median change of 0.52 (or the mean change of 0.66) percentage points, the price increase is proportionally smaller. The results suggest price increases of 0.056 and 0.071 euro cents for the median and mean changes in taxes, respectively.

Although the price increase (e.g., from 1.39 to 1.391 euros) appears small, two issues that we highlight put this estimate in context. First, because consumers exhibit high awareness of gas prices, an increase of 1 euro cent can plausibly affect purchased quantities.⁸ Second, we measure the *average* price over 1 year across all gas stations and over all days. Hence, temporary increases and increases at gas stations that face less elastic consumer demand—for example, those also open at night—are plausibly higher than 0.1 euro cent. To translate the tax-induced price increase into an estimate of the tax borne by consumers, we must make assumptions on the price elasticity of demand and the profit margin. Although the average E5 price is 139 euro cents per liter, most of the E5 price is de facto fixed. According to an industry report (see BFT, 2018), stations earn gross profits (including VAT) of around 10 euro cents per liter. Hence, we use a gross margin of around 7%. We assume an elasticity of -0.4 (see Coglianese et al., 2017; Knittel & Tanaka, 2019).

⁸Due to a lack of data, there is no direct paper that explores if small changes of 1 euro cent can affect quantities. However, prior literature argues that due to the increased use of search apps and other market transparency tools, it is plausible that consumers react to small price changes (Eckert, 2013). For example, Rossi and Chintagunta (2016) found price decreases of 0.5 euro cents per liter in an Italian setting where gas stations have to display prices and those of the next competitor. Moreover, Byrne and De Roos (2019) show that Australian gas stations change prices in low cent values, indicating that gas stations are aware that consumers react to small changes of a few cents.

TABLE 2 Local business tax and gas prices: Main regression results.

	District-year fixed effects		State-year fixed effects	
	(1)	(2)	(3)	(4)
<i>Tax Rate</i>	0.1100** (0.0440)	0.1076** (0.0460)	0.1144** (0.0495)	0.1140** (0.0511)
<i>Cars</i>		-0.1915 (0.9087)		-0.9342 (2.6268)
<i>Stations per Car</i>		-127.8723 (87.2701)		-141.6421 (110.5591)
<i>Population</i>		n.a.		0.4824 (2.7843)
<i>Unemployment Rate</i>		-0.2769 (0.1965)		-0.4290** (0.2004)
<i>Deficit</i>		0.0473 (0.0401)		0.0272 (0.0446)
<i>Property Tax</i>		0.0001 (0.0005)		-0.0000 (0.0005)
Gas station FE	Yes	Yes	Yes	Yes
State-year FE	No	No	Yes	Yes
District-year FE	Yes	Yes	No	No
Observations	53,919	53,919	53,919	53,919
Excluded singletons	342	342	342	342
Adj. within R^2	0.0003	0.0006	0.0003	0.0004
Adjusted R^2	0.9697	0.9661	0.9661	0.9675

Note: This table presents the main results of regressing *E5* fuel prices on the local business tax rate. Controls are included in Columns 2 and 4. Gas station and district-year fixed effects (FE) are included in Columns 1 and 2. Gas station and state-year FE are included in Columns 3 and 4. We report robust standard errors clustered at the municipal level in parentheses.

*, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

With these inputs (7% margin and price elasticity of -0.4), we can estimate the tax incidence falling on owners versus consumers (see Fuest et al., 2018; Suárez Serrato & Zidar, 2016). In our case, it seems implausible that gas stations can pass on higher local business taxes to employees via lower wages, although these workers potentially have lower skill levels, which would predict that a higher tax incidence falls on them (Fuest et al., 2018). This is because, in 2015, Germany introduced a minimum wage of 8.50 euros; that is, there is a binding lower limit to wages, and gas stations cannot push the wage below this limit. Hence, we assume that workers do not bear part of the tax burden in our case.⁹ However, we acknowledge that we do not have wage data for gas stations that would enable us to make a more exact calculation or to test this prediction empirically.

We approximate the percentage of the additional tax that owners bear by calculating the extent to which higher tax payments reduce after-tax profits; that is, we divide the after-tax profit reduction by the tax payment increase. This ratio captures the owner incidence. Subtracting this ratio from one captures the customer tax incidence. Assuming costs respond to output changes based on the profit margin, we calculate a range of incidence estimates

⁹We note that other tax incidence papers make similar simplifying assumptions. For example, Fuest et al. (2018) assume when calculating their incidence estimates that consumers do not bear part of the burden.

based on assumptions about: (1) price elasticity and (2) the profit margin. In our preferred back-of-the-envelope calculation, which we discuss in detail in Appendix 2, using a margin of 7% and a price elasticity of -0.4 , consumers bear about 64% of the corporate tax. Since the average quantity of gasoline sold per gas station is about 3.6 million liters, we apply our simple calculation to this quantity at a price of 1.39 euros per liter (the sample average). The additional tax burden related *only* to a one percentage point tax increase from 13.84% to 14.84% is about 4,000 euros.¹⁰ Hence, it is plausible that, with large quantities, gas stations can pass part of the tax burden on to consumers. Note that firms may not pass on the entire tax burden to consumers because the price elasticity is not zero. Passing on the entire burden would result in lower after-tax profits. One limitation of our approach is that we cannot derive estimates for scenarios with flexible capital stock or labor demand (see also Fuest et al., 2018). At least in theory, if taxes were passed on to employees, less of the tax burden would be borne by consumers.

Using three elasticity and three margin scenarios, Table 3 shows that consumers bear more of the tax burden if the demand elasticity (margin) is lower (higher). Some industry reports refer to after-tax margins being lower than 7%; others report margins well above 10%. Moreover, gas stations sell bundled products (e.g., beverages, tobacco, and car wash services) at higher margins and the industry is rather opaque on its true profitability due to antitrust investigations. In addition, some scenarios, such as a lack of price elasticity and a low margin (or high price elasticity and a high margin), are unlikely because low elasticity should translate into a high margin and vice versa (Lerner, 1934). For example, in the unlikely scenario of a lack of price elasticity and low margins, there could be an overpassing of corporate taxes to consumers, indicating that they would bear 126% of the tax. However, such overpassing of taxes is possible, for example, in oligopolistic markets (Dutkowsky & Sullivan, 2014; Weyl & Fabinger, 2013). Moreover, in Panel B of Table 3, we also present the range of estimates of the incidence falling on consumers for the other specifications in Table 2. On average, between 64% and 67% of the local business tax is borne by consumers.

Finally, we assess the validity of the pre-shock parallel trends assumption. We thus augment our baseline specification with the three leading tax rates. To test this, we add the tax rates over the period 2018–2020 to our sample. The results, shown in Figure 3, do not demonstrate any anticipation effects because the coefficients for all three leading tax rates (displayed as responses in $t - 1$ to $t - 3$) are insignificant. Importantly, these three tax rates are also jointly insignificant (t -stat = 0.12). Instead, E5 prices increase in response to a higher local business tax rate in year t . Furthermore, the difference between the coefficient estimate in t and the estimates on the lead terms is significant (t -stat = 2.13), and the magnitude of the difference (0.1158) is close to the baseline estimate. This result suggests that the parallel trends assumption holds in our setting.

4.2 | Characterizing the persistence and asymmetry of the price effect

One key question is whether the price change is permanent, or whether the effect might increase (e.g., because it may take some time before gas stations adjust factor inputs or exit the industry). To test this notion, we build on the changes model in Column 4 of Table 4 and add two lagged terms of the tax rate. Figure 4 then plots the cumulative effect of tax rate changes on gas prices. The results are consistent with a persistent and stable effect over at least 3 years. Although the slope of the effect appears to increase slightly, the increase is statistically insignificant.

¹⁰The 4,000 euros reflect the incremental tax of an *increase* in the local business tax by *one percentage point* per gas station. Given that the average tax is about 13.84%, this implies that the average tax burden is closer to 55,240 euros (= 4,000 euros \times 13.84). Hence, the aggregate tax revenues across our 14,255 gas stations of about 787 million euros, of which 64% would be borne by consumers, appear relevant in the aggregate.

TABLE 3 Incidence falling on consumers: Scenario analysis.

Panel A: Role of margins and quantity elasticities		Profit margin m		
		Low	Medium	High
Quantity elasticity ϵ		5%	7%	10%
No response	0.0	126%	95%	69%
Medium	0.4	86%	64%	46%
Higher	0.6	64%	47%	33%

Panel B: Main tests from Panel A, Table 2				
Specification	No controls district-year FE	With controls district-year FE	No controls state-year FE	With controls state-year FE
Consumer incidence	65%	64%	67%	67%

Note: This table translates our coefficient estimates into back-of-the-envelope estimates of the tax incidence falling on consumers. We assume that firms do not change capital or labor input and that the cost of capital and wage costs remain constant. We assume a quantity Q of 10 units and a price P of 139. The tax rate is $\tau = 13.84\%$. With a margin m , this results in a pre-tax profit of $P \times Q \times m$ and an after-tax profit of $\Pi = (1 - \tau) \times P \times Q \times m$. We then calculate the reductions in pre-tax profits and in tax payments following a tax rate increase of one percentage point to $\tau^* = 14.84\%$. Given our estimate of β_1 , we now have a price of $P^* = P + \beta_1$. The sold quantity changes depending on the quantity elasticity ϵ . The new sold quantity is thus $Q^* = Q \times [1 - \beta_1/(P \times \epsilon)]$. The latter term captures the percentage increase in the price (β_1/P); multiplication by ϵ results in a reduction in quantity. The new after-tax profit is $\Pi^* = (1 - \tau^*) \times [P \times Q \times m + (P^* \times Q^* - P \times Q) + (Q - Q^*) \times P \times (1 - m)]$, where $P \times (1 - m)$ represents the cost per unit sold. We now calculate the reduction in after-tax profits ($\Delta\Pi = \Pi - \Pi^*$) following the tax increase divided by the increase in taxes paid due to the tax increase ($\tau^* \times \Pi^* - \tau \times \Pi$), to obtain the percentage of the corporate tax borne by the firm. Subtracting this ratio from one gives the percentage of the tax borne by consumers. In our calculations, we assume different scenarios. We assume the elasticity ϵ to be zero (no response), 0.4 (medium), or 0.6 (higher). We also use three different cases of profit margins: 5% (low), 7% (medium), and 10% (high). Numbers in bold type indicate realistic combinations of ϵ and m . In Panel B, we transform our estimates from Table 2 into incidence estimates, assuming a margin of 7% and a quantity elasticity of 0.4. A more detailed description is available in Appendix 2. Abbreviation: FE, fixed effects.

We also test for a potential symmetric reaction, again building on the changes model. We split the effect captured by the $\Delta Tax Rate$ coefficient into tax cuts and tax hikes. We then plot the estimated effect of a change in the local business tax rate for different levels of $\Delta Tax Rate$ in Figure 5. Two observations are noteworthy. First, consistent with our main results, increases in *Tax Rate* are associated with higher gas prices. This effect is statistically significant. Second, and in contrast to tax hikes, we do not find any evidence of price changes (i.e., decreases) to tax cuts. Although prices rise following tax increases, they do not drop following tax cuts (see also Benzarti et al., 2020 and the case of the VAT). However, we advise the reader to consider one limitation: The number of tax cuts (41) and gas stations affected by these cuts (178) is limited. This explains the large confidence intervals. However, there should be at least some kind of observable trend toward lower prices in response to tax cuts. We do not see this trend. Bearing in mind these data limitations, our results indicate an asymmetric response, where only tax hikes are passed on to consumers.

4.3 | Robustness tests and additional identification

We probe the robustness of our main results by performing the following additional tests in Panel A of Table 4. First, we address concerns about the staggered DiD design raised in recent literature (A. Baker et al., 2022; Goodman-Bacon, 2021). We follow Barrios (2021) and exclude

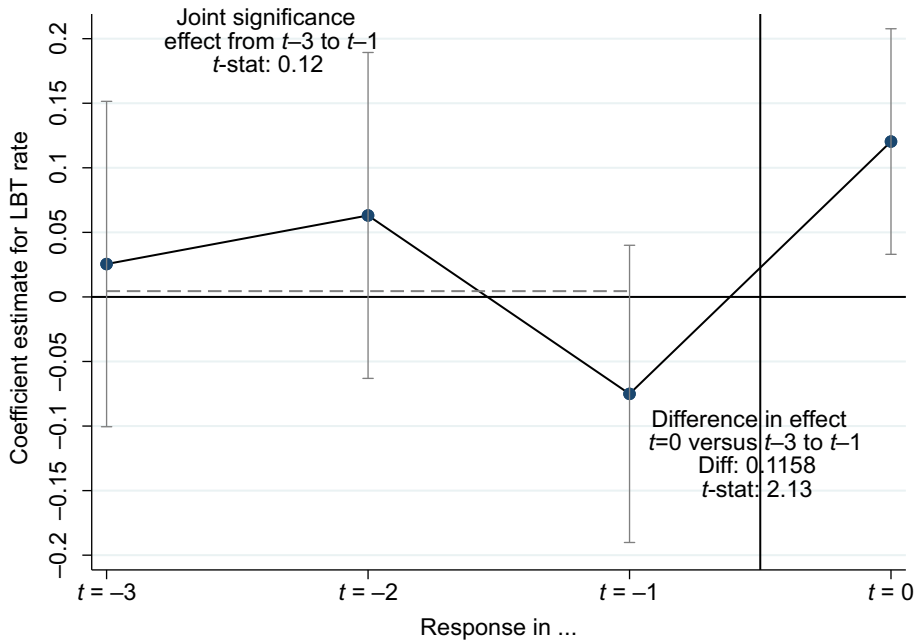


FIGURE 3 Pre-trends in gas prices. This figure presents the results of regressing E5 fuel prices on the local business tax rate. We use our baseline model and additionally include future tax rates to account for pre-trends. Confidence bounds are based on standard errors clustered at the municipal level. The vertical line separates pre-trends from the response in the year of the tax rate change.

municipalities without a change in their tax rate (Column 1). In addition, we compare municipalities with exactly one tax change to municipalities without any tax change at all in Column 2, which is closer to a standard DiD approach. In both cases, we find results that are very similar to those in our baseline approach with very similar magnitudes. Furthermore, to assess whether the effect size differs over time, we interact *Tax Rate* with year dummy variables. The results in Column 3 indicate that the effect is statistically significant in 3 of 4 years, with the effect of 2014 being insignificant, potentially because our data start only in June 2014.¹¹ We thus use the full sample throughout the paper to increase the power in our cross-sectional tests. Next, in Column 4, we examine a first-difference version of Equation (1). First differencing has the advantage of better facilitating multiple changes per municipality. The results are very similar to our main results.

Third, since all gas stations within a municipality have the same tax rate, there is no variation within the same municipality. Our coefficient estimate thus reflects only variation across municipalities. Since the number of observations in each municipality differs, our model could be misspecified (Solon et al., 2015). To address this issue, we run a weighted least squares (WLS) model with the number of observations in a municipality-year as weights (Column 5, Panel B). We find that using WLS does not change our estimate, supporting our main model.

¹¹To address concerns that the relation between our control variables for the local economic environment and E5 prices varies over time and across regions, we use tests (see Table A.3 in Appendix S1) that interact all control variables: (1) with year-fixed effects, to allow the coefficients of the control variables to vary over time, (2) with state-fixed effects, to allow the coefficients of the control variables to vary spatially, and (3) in a combination of approaches (1) and (2). We continue to find a positive effect of local business taxes on E5 prices with very similar magnitudes.

TABLE 4 Local business tax and gas prices: Robustness and identification.

Panel A: Robustness tests						
	Exclusion of no-change municipalities (1)	One-change municipalities versus no-change municipalities (2)	Breakdown by year (3)	Change model (4)	WLS (5)	Affected versus unaffected gas stations (6)
<i>Tax Rate</i>	0.1141** (0.0563)	0.1241** (0.0560)			0.1159** (0.0577)	-0.0406 (0.0881)
<i>Tax Rate</i> × 2014			0.0665 (0.0517)			
<i>Tax Rate</i> × 2015			0.1150** (0.0470)			
<i>Tax Rate</i> × 2016			0.1323*** (0.0476)			
<i>Tax Rate</i> × 2017			0.1488*** (0.0511)			
Δ <i>Tax Rate</i>				0.0995*** (0.0356)		
<i>Tax Rate</i> × <i>Affected</i>						0.2212** (0.1072)
Joint Significance [<i>t</i> -stat]						0.1806*** [2.80]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Gas station FE	No	No	Yes	No	Yes	Yes
District-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Model	OLS	OLS	OLS	First Diff.	WLS	OLS
Observations	20,635	43,233	53,919	39,574	53,919	29,638
Excluded singletons	204	220	342	0	342	126
Adj. within R^2	0.0006	0.0005	0.0006	0.0002	0.0004	0.0007
Panel B: Exploring variation within brands						
	Full sample (1)	Only <i>ARAL</i> (2)	Only <i>Shell</i> (3)	Only <i>ESSO</i> (4)	Only <i>TOTAL</i> (5)	
<i>Tax Rate</i>	0.1696*** (0.0562)	0.2298** (0.0977)	0.1106 (0.1274)	0.2317* (0.1311)	0.1898* (0.1129)	
Controls	Yes	Yes	Yes	Yes	Yes	
Gas station FE	Yes	Yes	Yes	Yes	Yes	
District-year FE	No	Yes	Yes	Yes	Yes	
Brand-district-year FE	Yes	No	No	No	No	
Observations	52,467	8,711	6,499	3,872	3,192	
Excluded singletons	12,748	197	269	416	367	
Adj. R^2	0.973	0.980	0.976	0.984	0.988	

Note: Panel A presents the results of robustness tests. In Column 1, we exclude all municipalities with no change in local business tax rate during our sample period. In Column 2, we compare municipalities with exactly one change during our sample period to municipalities with no change. Column 3 replicates Column 2 but adds interactions of *Tax Rate* with year dummy variables. In Column 4, we use a change specification with district-year fixed effects (FE) and controls (also in first differences). Column 5 replicates Column 2 of Panel A in Table 2 but uses weighted least squares (WLS) instead of OLS. The weights are the number of gas stations in a municipality-year. Finally, in Column 6, we interact *Tax Rate* with *Affected*, which is equal to one if the business is either incorporated or unincorporated and in a municipality with a local business tax rate above 13.3%. In Panel B, we further account for within-brand variation. In Column 1, we include brand-district-year FE. In Columns 2–5, we use our main specification, but individually partition the sample on the four largest gas station brands. See Appendix 1 for variable definitions.

*, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

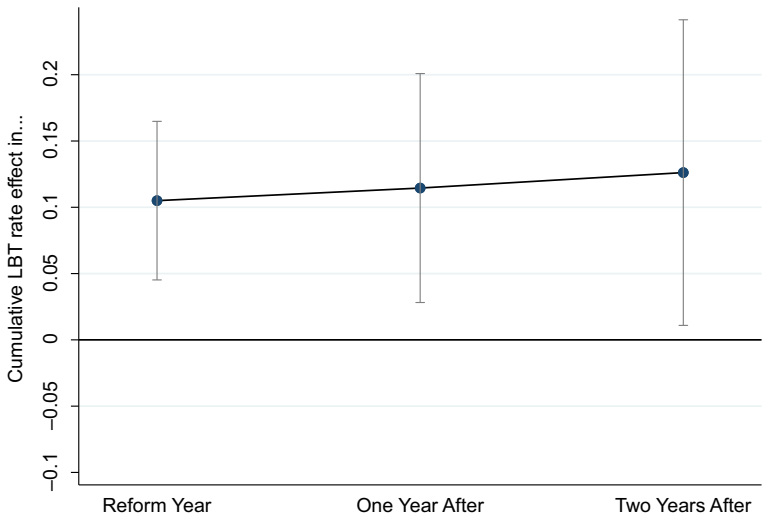


FIGURE 4 Cumulative effect of tax changes on gas prices. This figure presents the results of regressing changes in E5 fuel prices on current and lagged changes in local business tax rates. We use our baseline model and additionally include lagged tax rates. The figure plots the cumulative effect on gas prices of tax changes over time. Confidence bounds of 90% are based on standard errors clustered at the municipal level.

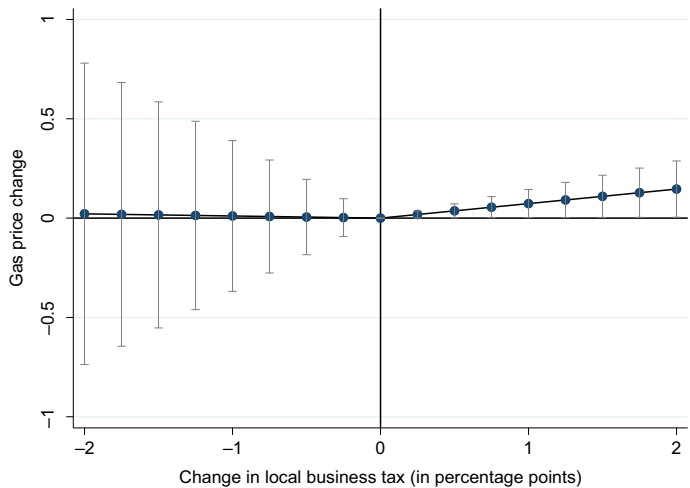


FIGURE 5 Effect of increases and decreases in tax rate. This figure presents the results of regressing changes in E5 fuel prices on changes in local business tax rates. We use a first difference version of our baseline model and split the *Tax Rate* coefficient into decreases and increases in tax rate. The figure plots the effect for different levels of tax rate changes. Confidence bounds of 94% are based on standard errors clustered at the municipal level.

Next, we address remaining concerns that unobserved local economic conditions are driving tax rate changes and E5 prices. We exploit the unique feature of the German tax system that unincorporated firms receive a tax credit of up to 13.3%. Incorporated firms do not receive such a tax credit. This feature provides us with a subsample of gas stations from the same municipality unaffected by local business taxes. We expand Equation (1) by additionally interacting *Tax Rate* with *Affected*, which is a dummy equal to one if the gas station is either incorporated or

an unincorporated firm subject to a local business tax rate above 13.3% in year t . The dummy variable *Affected* is zero for all unincorporated firms subject to a local business tax rate of 13.3% or lower in year t since their owners receive a credit for the full local business tax, and this tax is thus irrelevant to them. These firms should not respond to local business tax changes. In this setup, the *Tax Rate* coefficient captures the effect of local business taxes for these gas stations. Hence, we expect this coefficient to be insignificant. In contrast, we expect the interaction of *Tax Rate* and *Affected* to be positive and significant, consistent with the notion that affected gas stations pass business taxes on to consumers. Data on the organizational form are from Creditreform. We merge data based on the gas station's name and address. In Column 6 of Table 4, we present the regression results. The main effect of *Tax Rate*—the effect of *Tax Rate* for unaffected gas stations—is small and insignificant. Importantly, the interaction of *Tax Rate* and *Affected* is positive and significant at the 5% level, suggesting that affected gas stations' prices react to local business taxes. The joint significance test ($Tax Rate + Tax Rate \times Affected$) is significantly positive.¹²

In the final step, Panel B of Table 4 addresses the concern that the prices for different brands are set centrally at the level of the major oil company and that local taxes might not be factored in. We thus run a version of Equation (1) in which we include brand-district-year fixed effects. This specification compares gas prices within gas stations of the same brand across municipalities within the same district. We continue to find evidence for a statistically significant relationship between taxes and gas prices (Column 1). In Columns 2–5, we run our main model for each of the largest four (top) brands individually. Note that the identification now stems only from cases where one brand has multiple gas stations within one district across different municipalities. We continue to find evidence for the tax effect in three of the four cases. These tests support the notion that the major oil companies and their affiliated brands incorporate local business taxes in their prices.

5 | HETEROGENOUS EFFECTS OF TAXES ON CONSUMER PRICES

In the next step, we explore the heterogeneity in the gas price response to local business taxes. The objective of these tests is to understand when the passing of taxes on to consumers is more versus less prevalent. We first explore differences in tax planning opportunities and debt tax shields to link the price response to firms with worse access to alternative strategies to reduce the tax burden (Dyreng et al., 2022; Fuest et al., 2018). Second, we explore differences in the ability of gas stations to pass taxes on to consumers. Specifically, we examine differences in the relative elasticities of consumer demand and gas station supply to explore whether market power and related characteristics lead to higher passing of taxes to consumers.

5.1 | The role of tax planning opportunities and tax shields

We first test whether the corporate tax incidence on consumers is lower if firms have more opportunities to avoid taxes. Theory suggests that tax avoidance opportunities allow firms to absorb the effect of statutory tax rates, making consumer prices less sensitive to changes in the statutory tax rate. Put differently, because of tax planning and lower

¹²The *Tax Rate* coefficient for the firms missing organizational form data is positive and significant (not tabulated). Descriptive statistics (see Table A.4 of Appendix S1) comparing firms missing organizational form data with those used in Table 3 indicate that the two groups have similar tax rates. Firms with no information are in somewhat smaller districts and have slightly more market power. The latter difference could explain why these gas stations matter for the average response. In untabulated tests, we further show that 24,496 observations of the firms for which we have no information on their organizational forms are affected by local business taxes. Hence, we draw our main inferences from the full sample and use all available observations in the upcoming tests.

explicit tax payments, firms can invest more, and their investments are less sensitive to tax rate changes (Dobbins & Jacob, 2016; Shevlin et al., 2019). This implies that firms can operate at higher output and therefore also lower prices if they can avoid taxes; thus, consumers bear less of the corporate tax (Dyreng et al., 2022; Fuest et al., 2018). A similar argument can be made for debt-related tax shields. If more costs are tax deductible—for example, when using debt instead of equity financing—the adverse effect of taxes on investment becomes smaller, and less of the tax incidence falls on consumers. Similarly, under markup pricing, saved taxes from tax planning opportunities or debt shields likely enter a cost-plus calculus. Hence, if gas stations have tax planning opportunities or if firms have greater debt tax shields, we should observe less tax being passed on to consumers.

5.1.1 | Exploiting tax planning opportunities: Tax planning resources

We first test whether the ability of firms to exploit tax planning opportunities leads to lower tax incidence falling on consumers. As a proxy for planning opportunities and tax planning sophistication, we explore variation in the density of tax advisors within Germany. Zwick (2021) shows that tax advisors improve the take-up rate of tax deductions, which can affect small firms' effective tax rates. In our setting, this implies that if more tax advisors are available, gas stations have lower effective tax rates, which should translate into less tax passed on to consumers.

In Column 1 of Table 5, we find evidence to support this prediction. In areas with above-median density of tax advisors, measured by the number of tax advisors in a district scaled by the number of gas stations in a municipality, there is less passing on of taxes to consumers, as indicated by the negative interaction of *Tax Rate* \times *High Tax Advisor Density*. In the areas with low tax planning resources, the estimates suggest that between 107% and 115% of the corporate tax is passed on to consumers. In theory, a slight overpassing can occur in models of oligopolies and imperfect competition (Weyl & Fabinger, 2013), which appears to be descriptive of the gasoline market.¹³ These results suggest that tax planning opportunities have important implications for corporate tax incidence falling on consumers. Although taxes are passed on by firms with few tax planning opportunities, there is no evidence that the corporate tax is passed on to consumers by firms with many tax planning opportunities. Hence, limiting tax planning opportunities (e.g., through policy changes) may trickle down to consumers through higher consumer prices.

5.1.2 | Exploiting tax planning opportunities: The role of tax enforcement

To corroborate these findings, we exploit variation in tax enforcement. In Germany, tax enforcement is decentralized and set at the level of the 16 federal states. This regional variation in tax enforcement strength is plausibly unrelated to local tax rate changes because tax authorities do not set the rules, but only collect federal and local taxes. Moreover, there are substantial differences in tax enforcement strength among small- and medium-sized companies, such as gas stations. Based on data from the German Federal Ministry of Finance¹⁴ on

¹³We assess the validity in two additional analyses. First, while we do not have sufficient data for all individual gas stations to test whether they have lower effective tax rates, we test this assumption and thus provide some construct validity for *High Tax Advisor Density*, using all available Amadeus data on unconsolidated statements of German firms during our sample period. We find that firms have a 1.1 percentage point lower effective tax rate in *High Tax Advisor Density* areas relative to the other areas (not tabulated). Second, we address the concern that tax advisor density picks up urban versus rural areas or competition. When additionally including interactions of *Tax Rate* with *Urban* and/or with *High Competition*, our results remain significant with similar magnitudes (see Table A.5 of Appendix S1).

¹⁴Data were provided by the German Federal Ministry of Finance, but we are not allowed to share or forward the data.

TABLE 5 Tax planning and tax minimization opportunities and tax incidence.

Split by	Tax advisor density (1)	Additional revenue (2)	Auditors per tax office (3)	Placebo, largest firms' enforcement (4)	Debt (5)	Credit limit (6)
<i>Tax Rate</i>	0.1935*** (0.0617)	0.1976*** (0.0670)	0.2512* (0.1502)	0.1538 (0.0976)	0.8622** (0.3461)	0.1645** (0.0737)
<i>Tax Rate</i> × <i>High Tax Advisor Density</i>	-0.1465** (0.0682)					
<i>Tax Rate</i> × <i>Low Enforcement</i>		-0.1737** (0.0879)	-0.3209** (0.1634)	-0.0632 (0.1072)		
<i>Tax Rate</i> × <i>High Debt</i>					-0.8568** (0.3941)	
<i>Tax Rate</i> × <i>High Credit Limit</i>						-0.0788** (0.0401)
Joint Significance	0.0469	0.0240	-0.0696	0.0906*	0.0054	0.0858
[<i>t</i> -stat]	[0.88]	[0.40]	[0.88]	[1.81]	[0.01]	[1.17]
Controls and gas station FE	Yes	Yes	Yes	Yes	Yes	Yes
District-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	53,919	53,843	19,029	53,843	1,149	13,227
Excluded singletons	342	18	126	18	448	1,492
Adjusted <i>R</i> ²	0.979	0.970	0.969	0.970	0.969	0.975

Note: This table presents the results of cross-sectional analyses regarding the tax minimization strategies. The dependent variable is *E5*. In Column 1, we interact *Tax Rate* with *High Tax Advisor Density*, a dummy equal to one if the ratio of tax advisors in a district (scaled by the number of gas stations in a municipality) is above the median in the state. Columns 2 to 4 explore tax planning opportunities due to lax tax enforcement. We interact *Tax Rate* with *Low Enforcement*, a dummy variable equal to one if the additional revenues in Column 2 (or tax auditors per tax office in Column 3) are below the median. Column 4 presents the results of a placebo test using tax revenues from the largest firms. We interact *Tax Rate* with *High Debt* in Column 5 and with *High Credit Limit* in Column 6; these are dummy variables equal to one if the gas station debt-to-assets ratio or credit limit, respectively, is above the median. We include gas station and district-year fixed effects (FE) in all columns. We report robust standard errors clustered at the municipal level in parentheses. See Appendix 1 for variable definitions.

*, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

additional tax revenues from tax audits for groups of different sizes (e.g., micro firms, small and medium-sized enterprises, and very large firms) for each state and year, we sort state-years according to the additionally collected revenues and define a dummy variable *Low Enforcement*, equal to one for observations below the median, and zero otherwise. We also use the number of total tax auditors per tax office (available for only a limited sample) as a proxy for stricter tax enforcement. We split the sample at the median to define *Low Enforcement*.¹⁵ The prediction is that in high enforcement states, more of the corporate tax incidence falls on consumers in the form of higher prices.

The results are presented in Columns 2–4 of Table 5. We find that firms facing stricter tax enforcement pass on more of the business tax burden to consumers, as indicated by the positive and significant *Tax Rate* coefficient in Columns 2 and 3. For observations with less strict enforcement (*Low Enforcement* = 1), that is, for firms with more tax planning opportunities, we find that business taxes have a significantly smaller impact, as indicated by the negative and

¹⁵We again calculate statistics on differences in effective tax rates based on available, unconsolidated German accounts during our sample period. Sufficient data for gas stations are not available. In untabulated mean comparisons, we find firms in high enforcement areas have effective tax rates that are higher by 1.05 percentage points when using the revenue-based enforcement measure and by 2.38 percentage points when using the staff-based enforcement measure.

significant *Tax Rate* \times *Low Enforcement* interaction.¹⁶ Specifically, there is no statistically significant evidence that the corporate tax is passed on to consumers when tax enforcement is weaker. Finally, we run a placebo test by using additionally collected tax revenues from the largest firms, which are unlikely to be gas stations. We find an insignificant interaction term in Column 5 because this enforcement variable is unrelated to enforcement in gas stations. These findings show that tax reductions via tax planning led to lower increases in consumer prices if taxes increase. If firms have less access to tax planning, consumers bear more of the local business tax.

5.1.3 | Exploiting tax code features: Debt-related tax shields

Next, we assess the role of debt tax shields. We test this notion by exploring the difference in debt versus equity financing. Using balance sheet information on the debt-to-assets ratio from Bureau van Dijk's Dafne database, which we match via the unique "Crefonumber" to the sample of gas stations with data from Creditreform, we split a small and limited sample of gas stations into high-debt firms (high level of deductibility) and low-debt firms (low level of deductibility), based on the firms' median debt-to-asset ratios. We then interact *Tax Rate* with the dummy *High Debt*. In addition, as a measure of debt capacity, we exploit gas stations' credit lines as estimated by Creditreform for about 13,000 observations. We split the sample into firms with high and low credit lines using the median. Firms with high credit lines form the group of firms with greater debt capacity and, thus, greater debt tax shield opportunities (*High Credit Limit*).

We find results consistent with theory (Columns 5 and 6, Table 5). Highly levered firms and firms with high debt capacity pass on less of the corporate tax burden to consumers, as indicated by the negative and significant interaction terms *Tax Rate* \times *High Debt* and *Tax Rate* \times *High Credit Limit*. In fact, we do not find a significant effect of taxes on consumer prices for those firms. In contrast, for firms with lower debt tax shields, we find that 93%–101% of the local business taxes are passed on via higher gas prices. These results indicate that a single key feature of almost every tax code around the world—the limited deductibility of investment costs—drives the corporate tax burden on consumers. These findings indicate that measures to reduce the tax burden, such as debt tax shields used in place of passing taxes on to consumers, dampen the tax incidence on consumers.

5.2 | The role of relative elasticities

Next, we explore heterogeneity in the extent to which local business taxes affect consumer prices based on economic forces. One of the fundamental principles of tax incidence is that the relative elasticity of demand vis-à-vis supply determines the extent to which consumers bear the tax burden (Weyl & Fabinger, 2013). Hence, we expect firms to shift more of the corporate tax to consumers when they face less elastic consumer demand also because firms can use more aggressive markup pricing. We test this conjecture in several ways in the following.

5.2.1 | Exploring gas station characteristics

We exploit gas station characteristics to group gas stations into those plausibly facing less vis-à-vis more elastic consumer demand. Specifically, we exploit the fact that some gas stations

¹⁶We note that these results are robust to including the interaction of *Tax Rate* and *Low Competition* to address for the concern that the local characteristic of *Low Enforcement* picks up differences in local competition (untabulated).

close at night, temporarily affording the stations that are always open (denoted by $24/7$) greater market power (Linder, 2018). This characteristic is linked to cases where close substitutes for customers are less accessible and less available.¹⁷ Hence, gas stations have (temporary) pricing power over customers. To capture instances where gas stations have limited pricing power, we define $No\ 24/7$ as $1 - 24/7$. We then expand Equation (1) by interacting $No\ 24/7$ with $Tax\ Rate$. Note that the main effect of $No\ 24/7$ is absorbed by gas station-fixed effects.

Results are reported in Table 6, Column 1. We find that firms with greater market power pass on more of the local business tax to consumers, as indicated by the significant $Tax\ Rate$ coefficient. The magnitude of the $Tax\ Rate$ coefficient is larger than in our main results; this is unsurprising because these gas stations have higher margins and because, in the case of firms with high market power, overpassing taxes would be consistent with theory (Weyl & Fabinger, 2013). Importantly, we find that gas stations with less market power shift less tax to consumers, as indicated by the negative $Tax\ Rate \times No\ 24/7$ coefficient. Since the sum of $Tax\ Rate$ and $Tax\ Rate \times No\ 24/7$ is insignificant, the results suggest that gas stations with low market power do not pass taxes on to consumers. One caveat of this test is that we do not have a breakup of sales by day and night.

We also examine the role of local competition. If gas stations face more competition—that is, consumers have more local close substitutes—we expect them to be less able to pass corporate taxes on to customers. We operationalize this notion by combining low demand (proxied by the number of cars per inhabitant) and high supply (proxied by the number of gas stations per inhabitant). We then define a dummy variable $High\ Competition$ equal to one if the municipality is characterized by high supply (i.e., the municipality is above the median number of gas stations per inhabitant) and low demand (i.e., the municipality is below the median number of cars per inhabitant). Column 2 presents the result. Consistent with our prediction, we find that the main effect on $Tax\ Rate$ is positive and significant, suggesting that gas stations pass about 88%–96% of the tax on to consumers via higher prices in municipalities with low competition. The negative interaction of $High\ Competition \times Tax\ Rate$ shows that gas stations in highly competitive markets are less able to pass taxes on to consumers. The insignificant sum of $Tax\ Rate$ and $High\ Competition \times Tax\ Rate$ suggests that gas stations in highly competitive markets cannot pass on local business taxes.

5.2.2 | Exploring price differences along the border

Next, we explore differences in the availability of close substitutes along the German border. Germany shares borders with nine countries. In four of them (Austria, the Czech Republic, Luxembourg, and Poland), E5 is much cheaper, which makes German and foreign consumers at the border more elastic at German gas stations, as they can buy outside Germany. In Belgium, Denmark, France, the Netherlands, and Switzerland, E5 is much more expensive, making consumers relatively less elastic because gas stations do not face fierce competition from abroad. We create a dummy variable $Low\ Price\ Abroad$, which equals one if the district shares a border with Austria, the Czech Republic, Luxembourg, or Poland, and zero otherwise. Districts without a border to a foreign country are excluded from this test. We then interact $Low\ Price\ Abroad$ with $Tax\ Rate$. Column 3 in Table 6 reports the results. The $Tax\ Rate$ coefficient represents the effect in districts that share a border with a country with higher E5 prices. The

¹⁷Our findings are robust to using gas stations located on highways with the idea being that consumers are relatively inelastic due to the high switching costs (Haucap et al., 2017; McAfee et al., 2004). We exploit the fact that gas stations belonging to top brands have greater market power because of higher consumer loyalty (Hastings, 2004) and their coordinated pricing (Bronnenberg et al., 2012, 2015). Finally, we explore very geographically close stations, which tend to coordinate their pricing to increase their combined market power vis-à-vis consumers. Using either of these characteristics or a composite measure of market power combining these four characteristics yields similar insights (see Table A.6 of Appendix S1, where we also include municipality-year fixed effects).

TABLE 6 Local business tax, market power, and gas prices.

	(1)	(2)	(3)	(4)
<i>Tax Rate</i>	0.3076*** (0.0676)	0.1522*** (0.0497)	0.4744*** (0.1683)	0.1547*** (0.0425)
<i>Tax Rate</i> × <i>No 24/7</i>	-0.3565*** (0.0697)			
<i>Tax Rate</i> × <i>High Competition</i>		-0.1819** (0.0763)		
<i>Tax Rate</i> × <i>Low Price Abroad</i>			-0.8044** (0.2846)	
<i>Tax Rate</i> × <i>Diesel</i>				-0.0984*** (0.0124)
Joint Significance	-0.0489	-0.0297	-0.3300	0.0563
[<i>t</i> -stat]	[1.00]	[0.41]	[1.36]	[1.32]
Controls	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No
Gas station FE	Yes	Yes	Yes	Yes
District-year FE	Yes	Yes	No	Yes
Observations	38,329	56,919	6,617	108,520
Excluded singletons	200	342	45	0
Adjusted R^2	0.9408	0.9710	0.9579	0.9871

Note: This table presents the results of cross-sectional analyses regarding the regression of *E5* on the local business tax rate. In Column 1, we include the interactions of *Tax Rate* with *No 24/7*, a dummy variable equal to one if the gas station does not open 24 h a day and 7 days a week. In Column 2, we interact *Tax Rate* with *High Competition*, a dummy variable equal to one if the municipality is characterized by low demand (below-median number of cars per inhabitant) and high supply (above-median gas stations per inhabitant). In Column 3, we interact *Tax Rate* with *Low Price Abroad*, a dummy variable equal to one if the district shares a border with Austria, the Czech Republic, Luxembourg, or Poland, and zero if the district shares a border with Belgium, Denmark, France, the Netherlands, or Switzerland. One district shares a border with Luxembourg and France, and another shares a border with Luxembourg and Belgium. Due to access to Luxembourg, we treat these districts as having a border with a low-price environment. Districts without a border are excluded from this test. In Column 4, we use two observations for each gas station, where the dependent variable *Price* is either the gasoline price (*E5*) or the diesel price (*Diesel*). We then include the interaction of *Tax Rate* with *Diesel* to capture the effect for *Diesel* fuel. We report robust standard errors clustered at the municipal level in parentheses. See Appendix 1 for variable definitions.

*, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

positive coefficient suggests that in these districts—because of the lack of cheaper substitutes abroad—German gas stations can pass on the local business tax. In contrast, the *Low Price Abroad* × *Tax Rate* coefficient is negative and significant, suggesting that higher local business tax rates do not result in higher *E5* prices in districts that share a border with a country where *E5* is less expensive than in Germany. The sum of the coefficients is insignificant at any conventional level (*t*-stat = 1.36).

5.2.3 | Comparing different product types

Finally, we extend our analysis to other products with different levels of consumer demand elasticity. Specifically, we examine diesel. Diesel fuel is mostly consumed by drivers of business vehicles (e.g., trucks and delivery vans) and other frequent drivers. These drivers are more likely to choose gas stations based on price actively. For example, logistics companies apply sophisticated route planning and algorithms to minimize costs since fuel is a main cost driver. Hence, we expect diesel consumers to be more price-conscious and more elastic. Put differently, we

expect the effect of local business taxes to be greater on gasoline prices (i.e., for E5) than on diesel prices.

For each gas station, we observe both the price of E5 and the price of diesel. In our empirical test, each gas station enters the regression twice, once with its E5 price and once with its diesel price. The dependent variable *Price* is, therefore, either the E5 or diesel price. We then include a dummy variable *Diesel*, which is equal to one if *Price* is the price of diesel, and the interaction $Diesel \times Tax Rate$ in our baseline model. Results are shown in Table 6, Column 4. We find that E5 prices respond to the local tax, as indicated by the positive *Tax Rate* coefficient. Consistent with the prediction that, because diesel demand is more elastic, more of the local business tax is passed on to consumers in case of gasoline, we find a negative and significant interaction of $Tax Rate \times Diesel$.

Overall, the results in this section corroborate the prediction that gas stations facing less elastic consumers pass more of the business tax on to them. Although this result mirrors an empirical regularity for sales taxes (Poterba, 1996), it is novel for corporate taxes and plausibly arises because the corporate tax base limits the deductibility of costs. Because the corporate tax does not allow firms to deduct their economic costs from sales revenues, it distorts firms' marginal after-tax costs and, therefore, has effects that we show are similar to those of sales taxes (Brekke et al., 2017).

6 | RELATED REAL EFFECTS OF TAXES

In this section, we link our findings to the previous literature on the real effects of taxes—that is, that taxes result in reduced factor inputs and may result in higher exit rates. Both effects would be consistent with the theoretical channels underlying the passing of taxes onto consumer prices; that is, these tests aim at providing some evidence that the price increases to taxes occur contemporaneously with other real effects documented by earlier literature and explicitly predicted by theory in the classical approach. However, a price-increasing behavior rooted in markup (e.g., cost-plus) pricing could have similar effects, even though the theory here is less explicitly developed by prior literature. Hence, these tests cannot clearly disentangle the markup-based explanation from the one focusing on downsizing. Also, we caution that the following tests lack financial data on gas stations and selection issues (e.g., we only cover larger gas stations).

6.1 | Taxes and gas station investment

Based on prior literature (Djankov et al., 2010; Faulkender & Petersen, 2012; Giroud & Rauh, 2019; Jacob et al., 2019; Zwick & Mahon, 2017), we assume that taxes affect gas stations' investments. In the very short run (i.e., daily or monthly level), investments of gas stations comprise working capital investments tied into their inventory of gas. In the longer run (e.g., the annual level), gas stations make frequent additional investments, such as upgrading or adding pumps, installing pumps with card payment systems, or adding other gasoline products. Moreover, because the useful life prescribed by tax authorities for a gas station implies that such maintenance amounts to 10% of the capital stock per year, gas stations need to make frequent and sizable maintenance investments.

To show that gas stations' investments respond to taxes, we use a limited subsample of gas stations that we can link to unconsolidated firm data from Dafne. Due to limited data availability, we are not able to construct investment measures, such as capital expenditures or changes in fixed assets. Hence, we must use a rather crude proxy of investments: the change in total

assets.¹⁸ In Table 7, Columns 1 and 2, we explore the responsiveness of gas stations' total assets to local business taxes.¹⁹ We find that higher taxes reduce total assets in this low-power test. As an alternative factor input, we use the natural logarithm of the number of employees in Columns 3 and 4 in Table 7. We find that local business taxes reduce employment (see also Giroud & Rauh, 2019; Ljungqvist & Smolyansky, 2018). This result is consistent with the downsizing of gas stations (i.e., fewer employees and less capital) in response to higher taxes leading to higher prices.

6.2 | Exit and rating downgrades

Next, we examine the prediction by Brekke et al. (2017) that the higher price due to taxes can be explained by firms exiting the market. We assess this notion in two ways. First, we create a dummy variable *Exit*, which equals 100 if the gas station reports gas prices in year t , but not in year $t + 1$, and zero otherwise. The year 2017 is excluded from this analysis; 0.5% of the gas stations in our sample exit the market. Since this percentage is very low, we can only include year fixed effects or state-year fixed effects. Second, we exploit the limited data on credit ratings from Creditreform ranging between 0 and 5. We define a dummy variable *Rating Downgrade*, which equals one if the gas station's credit rating decreased by 0.1 points or more, and zero otherwise. The idea is that if taxes increase and if this increases the likelihood of exit, we expect a lower credit rating. Columns 5–8 of Table 7 report the results. We find that a higher local

TABLE 7 Real effects of local business taxes.

Dependent variable	<i>Capital Investment</i>		<i>Ln(Employees)</i>		<i>Exit</i>		<i>Rating Downgrade</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Tax Rate</i>	-0.0532** (0.0220)	-0.0502** (0.0247)	-0.0697** (0.0328)	-0.0640* (0.0357)	0.0621** (0.0308)	0.0693* (0.0407)	0.0096** (0.0047)	0.0096* (0.0054)
Controls	No	Yes	No	Yes	Yes	Yes	Yes	Yes
Gas station FE	Yes	Yes	Yes	Yes	No	No	No	No
Year FE	No	No	No	No	Yes	No	Yes	No
State-year FE	Yes	Yes	No	No	No	Yes	No	Yes
District-year FE	No	No	Yes	Yes	No	No	No	No
Observations	1,226	1,189	9,271	8,729	41,316	41,316	7,363	7,363
Excluded singletons	153	145	2,002	1,936	0	0	0	0
Adjusted R^2	0.040	0.042	0.774	0.772	0.006	0.006	0.004	0.008

Note: This table presents the results for the tax sensitivity of gas station-level investment. The dependent variable is *Capital Investment*, which is the logarithmic growth rate in total assets from year $t - 1$ to year t in Columns 1 and 2. In Columns 3 and 4, the dependent variable, *Ln(Employees)*, is the natural logarithm of the number of employees. In Columns 5 and 6, the dependent variable is *Exit*, which is an indicator variable equal to 100 in the last year with information on gas prices at a gas station, and zero otherwise. We exclude the year 2017 from this analysis. In Columns 7 and 8, the dependent variable is *Rating Downgrade*, which is an indicator variable equal to 100 if the gas station's credit rating (from the rating agency Creditreform) decreases by 0.1 points or more, and zero otherwise. We report robust standard errors clustered at the municipal level in parentheses. See Appendix 1 for variable definitions. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

¹⁸This creates the concern that changes in total assets might be affected by changes in cash holdings. However, we note that for a broader sample of gas stations in Europe for which we have access to financial statement information (using Amadeus data), we find that changes in total assets are very highly correlated with changes in fixed assets (correlation coefficient of 0.67) and correlated with changes in inventory (correlation coefficient of 0.37), but that changes in total assets are less related to changes in cash holdings (correlation coefficient of 0.28).

¹⁹We are not able to include district-year fixed effects in these tests, so we include state-year fixed effects.

business tax is associated with a higher likelihood of exiting the gas station market and a higher likelihood of a downgrade in credit rating. These two findings support the theoretical predictions by Brekke et al. (2017).

Overall, the results in Table 7 support the idea that taxes reduce gas station scale and that firms may exit because of higher taxes. These results illustrate that the price increases due to taxes that we document could be rooted in the adverse effect of taxes on capital input and the number of firms in a market. However, other forms of pricing, such as markups, may have similar economic consequences (e.g., if a fixed markup leads to prices that are too high, this will likely result in downsizing), which makes it hard to disentangle potential theoretical explanations empirically.

7 | CONCLUSION

This paper shows that consumers bear part of the corporate tax burden in the form of higher prices. Using reported data on gas prices from nearly all German gas stations and local variations in business tax rates in 4,474 municipalities, we show that higher local business taxes increase consumer prices. We further show that the effect of business taxes on prices increases when gas stations have limited tax planning opportunities or lack other tax shields. In addition, we find that more of the tax incidence falls on gas stations if they have lower market power.

Our results have implications not only for policy-makers and the public debate but also for the academic literature. Passing corporate taxes on to consumers is a way of creating a tax shield. Hence, firms' investment (Djankov et al., 2010; Giroud & Rauh, 2019) and capital structure decisions (Heider & Ljungqvist, 2015) are potentially affected by the degree to which firms can pass taxes on to consumers. However, one caveat of our results is that they are based on a peculiar market—namely, the German retail gasoline market. Although the economic forces driving our findings (e.g., the relative elasticity of supply and demand or access to tax avoidance opportunities) are likely at work in other markets, future research could probe the generalizability of our findings.

Despite these limitations, our findings are important for tax policy debates. Our results suggest that increasing corporate taxes affects not only capital owners and low-skilled workers but also consumers through higher product prices. Our paper illustrates a very similar point for tax enforcement. Even if an increase in tax enforcement—for example, as implemented through the *Inflation Reduction Act of 2022* in the United States—leads to a reduction in tax planning (Hoopes et al., 2012; Kubick et al., 2016), firms may not fully bear the additional tax burden themselves, but may instead partially shift it to consumers. Likewise, recent policy attempts to tax “windfall” profits of the fossil fuel sector may result in greater consumer prices, but not hit firm owners fully. Moreover, our results also have implications for policy debates on increased corporate tax burdens, for example, via a global minimum tax. Increasing firms' tax burdens may come at the expense of consumers, who may face higher prices as a result of such policies. Future research could analyze this potential effect for multinationals, which our sample does not cover.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX 1: VARIABLE DEFINITIONS

Variable	Definition
Gas station-level variables	
<i>E5</i>	Price for 1 L of regular gasoline with 5% ethanol. <i>Source:</i> Tankerkönig (https://creativecommons.tankerkoenig.de). Prices are winsorized at 1 and 2 euros
<i>Affected</i>	Dummy variable equal to one if the gas station is either incorporated or unincorporated and subject to a <i>Tax Rate</i> above 13.3%
<i>Incorporated</i>	Dummy variable equal to one if the gas station is set up as an incorporated firm (e.g., corporation or limited liability company)
<i>Unincorporated</i>	Dummy variable equal to one if the gas station is set up as an unincorporated firm (e.g., a partnership or sole proprietorship)
<i>24/7</i>	Dummy variable equal to one if the gas station is open 24 h a day and 7 days a week (Google data, www.google.com)
<i>No 24/7</i>	Defined as $1 - 24/7$
<i>High Debt</i>	Dummy variable equal to one if the debt-to-assets ratio of the gas station is above the median
<i>High Credit Limit</i>	Dummy variable equal to one if the gas station's credit limit is above the median
<i>Credit Limit</i>	Gas station's credit limit in EUR (Creditreform)
<i>Employees</i>	Gas station's number of employees
<i>Total Assets</i>	Gas station's total assets
<i>Revenues</i>	Gas station's revenues
<i>Exit</i>	Dummy variable equal to 100 if a gas station exits the market
<i>Rating Downgrade</i>	Dummy variable equal to one if a gas station's credit rating declines by more than 0.1 point (Creditreform)
Municipal-level variables	
<i>Tax Rate</i>	Local business tax rate (Federal Statistical Office of Germany)
<i>Cars</i>	Number of registered cars per municipality (Federal Motor Transport Authority, https://www.kba.de/DE/Statistik/statistik_node.html)
<i>Stations per Car</i>	Total number of gas stations over our sample period divided by the number of registered cars per municipality (own calculation)
<i>Unemployment Rate</i>	Natural logarithm of the lagged unemployment rate per municipality (Federal Agency of Labor, https://statistik.arbeitsagentur.de)
<i>Deficit</i>	Municipality's budget deficit per capita (Federal Statistical Office of Germany)

(Continues)

APPENDIX (Continued)

Variable	Definition
<i>High Tax Advisor Density</i>	Dummy variable equal to one if the ratio of tax advisors in a district (scaled by the number of gas stations in a municipality) is above the median in the state
<i>Property Tax</i>	Local multiplier of the property tax within the municipality (Federal Statistical Office of Germany)
<i>Population</i>	Municipality's number of inhabitants (Federal Statistical Office of Germany)
<i>Low Enforcement</i>	Dummy variable equal to one if additional revenues (or tax auditors per tax office) are below the median (German Federal Tax Authorities)
<i>Additional Revenue</i>	Additional tax income generated from tax audits in a state (German Federal Tax Authorities)
<i>Tax Auditors by Office</i>	Number of tax auditors per office in a state (German Federal Tax Authorities)

APPENDIX 2: BACK-OF-THE-ENVELOPE CALCULATION OF THE TAX INCIDENCE

We consider a gas station that sells 10 units at a price of 139 euro cents per unit, thus, gross sales of 1,390 euro cents. Given the assumed profit margin of 7%, the pre-tax profit is 97.30 euro cents ($= 7\% \times 1,390$). For the sample average tax rate of 13.84%, the tax burden is 13.47 euro cents ($= 97.30 \times 13.84\%$), leading to an after-tax profit of 83.83 euro cents ($= 97.30 - 13.47$). We now consider a tax rate increase of one percentage point. In this case, that is, for a tax rate hike from 13.84% to 14.84%, our estimate implies that the average annual gas price increases to 139.1076 euro cents ($= 139$ plus the coefficient estimate of 0.1076). Given the price elasticity of demand, -0.4 , the demanded gas quantity falls from 10 to 9.997. This reflects a 0.031% decline in demand due to the 0.077% ($= 0.1076/139$) price increase. The drop in quantity sold (0.031%) is calculated as the price elasticity (-0.4) times the price increase (0.077%). This results in the new quantity of 9.997 ($= [1 - 0.4 \times 0.077\%] \times 10$). With this reduced quantity and the increased price, the new gross sales are 1,390.65 euro cents ($= 9.997 \times 139.1076$). To arrive at the new pre-tax profit for the higher tax rate, we start with the previous profit of 97.30 euro cents. We then add the increase in revenue of 0.65 euro cents ($= 1,390.65 - 1,390$). Moreover, the firm has lower costs: Given the profit margin of 7% (i.e., costs of 93%) and the reduced quantity sold, the firm saves costs of 0.04 euro cents. This results in a pre-tax profit of 97.99 euro cents ($= 97.30 + 0.65 + 0.04$). This profit is subject to local business tax at a tax burden of 14.54 euro cents ($= 14.84\% \times 97.99$), resulting in a net profit of 83.44 euro cents ($= 97.99 - 14.54$). To arrive at the incidence borne by owners versus consumers, we relate the tax increase to the reduction in after-tax profits. Of the 1.07 increase in the tax burden (14.54 euro cents at 14.84% minus 13.47 euro cents at 13.84%), 36% is borne by the firm in the form of lower after-tax profits: This 36% is calculated as the decline in after-tax profits of 0.39 euro cents ($= 83.83 - 83.44$) that owners face, divided by the additional tax burden of 1.07 euro cents ($36\% = 0.39/1.07$). Hence, the remaining 64% of the tax burden is borne by consumers.

	Base case		After tax hike of 1 percentage point
Price	139.00	Price	139.1076
Quantity (demand)	10.00	Quantity (demand)	9.997
Gross sales	1,390.00	Gross sales	1,390.65
Gross profit (assumed margin of 7%)	97.30	Gross profit (assumed margin of 7%)	97.30
		Increase in revenue (1,390.65 – 1,390.00)	0.65
		Lower costs due to lower quantity sold	0.04
Pre-tax profit	97.30	Pre-tax profit	97.99
Tax burden (13.84% sample average tax rate)	13.47	Tax burden (14.84% sample average tax rate)	14.54
After-tax profit	83.83	After-tax profit	83.44

The values are obtained as follows:

- Price after tax hike: 139.1076 euro cents (= 139 plus the coefficient estimate of 0.1076).
- Quantity after tax hike: 9.997 is calculated as 1 minus the price elasticity (–0.4) times the price increase (0.077%) times 10 (= $[1 - 0.4 \times 0.077\%] \times 10$).
- Lower costs: given the profit margin of 7% (i.e., costs of 93%) and the reduced quantity sold, the firm saves costs of 0.04 euro cents (= $139 \times 0.93 \times 0.1076 / 139 \times 0.4$).
- Tax incidence borne by the firm: 36% is calculated as the decline in after-tax profits divided by additional tax burden (= $(83.83 - 83.44) / (14.54 - 13.47)$).
- Tax incidence borne by consumers: 64% (= $1 - 0.36$).