SFB/Transregio 266
ACCOUNTING FOR TRANSPARENCY

WORKING PAPER SERIES

No. 15 | January 2020

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TRR 266 Accounting for Transparency

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation):
Collaborative Research Center (SFB/TRR) – Project-ID 403041268 – TRR 266 Accounting for Transparency

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Martin Jacob, Maximilian A. Müller, Thorben Wulff*

January 2020

ABSTRACT

We examine whether consumers bear corporate taxes through higher prices. Using data on the gas prices of German gas stations and local variation in business tax rates, we find that higher business taxes increase consumer prices, indicating corporate taxes fall partly on consumers. The effect of business taxes on gas prices increases if consumer demand is less elastic, local markets are less competitive, and when local gas stations coordinate. These results suggest that firms reduce their corporate tax burden by shifting taxes to stakeholders not just profits to low-tax countries.

Keywords: Corporate tax, tax incidence, tax policy

JEL classification: D12; H22; H25; H26

* Jacob is at WHU – Otto Beisheim School of Management (martin.jacob@whu.edu), Müller is at ESMT Berlin (Maximilian.Mueller@esmt.org), and Wulff is at WHU – Otto Beisheim School of Management (thorben.wulff@whu.edu).
We thank Kathleen Andries, Antonio De Vito, Nadja Dwenger, John Gallemore, Jochen Hundsdoerfer, Xu Jiang, Wayne Landsman, Marcel Olbert, Dirk Schindler, Robert Ullmann, Maximilian Todtenhaupt, Martin Thomsen, and participants of the Summer Finance and Accounting Conference at the Hebrew University of Jerusalem, the TRR 266 Annual Conference 2019 in Mannheim, the University of Graz, the University of Münster, and the WHU – Otto Beisheim School of Management for helpful comments and suggestions. Jacob and Wulff acknowledge funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 403041268 – TRR 266 Accounting for Transparency.

1. Introduction

Fueled by salient examples of tax avoidance schemes, corporate tax avoidance has received much attention from media, policymakers, and research. While this literature studies how firms reduce their tax payments by shifting profits to low-tax countries, we study whether firms reduce their tax burden by shifting taxes to consumers. This issue of tax incidence is less salient and observable than effective tax rates, but theory (e.g., Slemrod and Yitzhaki 2002, Dyreng et al. 2019) highlights important interactions between how much the firm bears in taxes (affecting its pre-tax income) and how much the firm avoids taxes (affecting taxes paid). Yet, there is little credible evidence on firms' passing on corporate taxes to their stakeholders.[1] Accordingly, we examine this issue exploiting granular price data and local tax variation. We also study the economic forces behind the shifting of taxes to stakeholders to highlight where tax incidence may plausibly interact with tax avoidance. Since passing on taxes to consumers can also be rooted in specific tax code features introduced to curb tax avoidance (e.g., limiting interest deductibility), our study also informs the ongoing tax policy debate, e.g., the OECD Base Erosion and Profit Shifting (BEPS) project.

While theory on whether firms can shift corporate taxes to consumers is mixed (e.g., the reviews by Harberger 2008, Gravelle 2013), a key assumption determining tax incidence relates to how the tax base is defined. Many models assume the full deductibility of factor input costs (e.g., the cost of financing). Under this assumption, taxes do not affect prices in the short run, since taxes do not change factor demands and are a de facto lump sum tax borne by firm owners. No implemented corporate tax code, however, features full deductibility (e.g., the cost of equity is often not deductible). Notably, if no costs were deductible, the corporate tax would not tax profits, but sales (e.g., Brekke et al. 2017). In that case, consumers bear more of the tax (i.e., prices increase more) the less elastic their demand is relative to the elasticity of firms' supply (e.g., Poterba 1996).

[1] Fuest et al. (2018) show that employees partly bear corporate taxes. Gordon (1967) finds no evidence for consumers, but Sebold (1979) finds price effects at the industry level and Vasquez-Ruiz (2012) in capital-intense industries in the long-run. In a contemporaneous working paper, Baker et al. (2019) confirm our findings using product-level US prices.

Empirically, neither polar case—full or no deductibility of costs—is descriptive for the corporate tax codes ranging somewhere in between. Hence, we expect that the relative elasticity of demand vis-à-vis supply remains a key determinant of whether consumers bear corporate taxes, particularly for firms with relatively high capital input.[2] Therefore, in this paper we test two predictions (see also Gordon 1967): (1) whether consumers bear part of the corporate tax burden and (2) how this effect varies as a function of the relative elasticity of supply vis-à-vis demand (a concept closely related to market power, e.g., through the Lerner index).

We test these predictions in the setting of Germany's retail gasoline market. This setting has two important advantages. First, each of the roughly 11,000 German municipalities can set its own tax rate on profits of businesses, the so-called local business tax rate. The tax rates range between 7% and 19.25% and are, hence, economically significant and salient (relative to the 15% federal tax). We can isolate the effect of taxing business profits on consumer prices because the tax base and other relevant taxes do not vary within Germany, and tax rates change mostly for political reasons (Foremny and Riedel 2014), not in response to business cycle shocks (Fuest et al. 2018).

Second, we focus on the retail gasoline market because gas stations are relatively capital intense, implying that their investment costs are likely only partially deductible, opening a channel through which corporate taxes could affect prices. However, it is ex ante unclear whether they do so for gasoline prices. While textbooks typically feature gasoline as a necessity good with relatively inelastic demand (e.g., Cabral 2017, Ch. 2), the supply side, capital, is also inelastic in the short run, since a gas station cannot be easily moved (e.g., Gruber 2019, Ch. 19) and consumers can buy gas in other municipalities. The *German* gasoline market is also opportune because the price changes for roughly 15,000 gas stations selling a homogeneous good are observable with high quality. The advantage of price data is that they allow us to isolate whether taxes are passed on to

[2] At least in the short run, we argue that, if there is no perfect competition in a product market, for instance, due to entry barriers and high up-front investments, firms are theoretically able to pass on the corporate tax to consumers. Although this prediction could change in the long-run, our empirical approach captures these short-run responses.

consumers. The setting also allows us to exploit differences across markets (e.g., the intensity of competition), within markets across gas stations (e.g., some belonging to a large brand or location at a highway), or within gas stations across fuel types (e.g., differing in how price-savvy their consumers are) to examine heterogeneity in the extent to which consumers bear the corporate tax. Illustrating these economic channels underlying the shifting of corporate taxes to consumers is important because it allows connecting our results from a setting with plausibly high internal validity to other settings and variables of interest (e.g., how market power affects tax avoidance and other firm decisions).

Empirically, we combine these features and employ a generalized difference-in-differences specification. That is, 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 that are not experiencing a tax rate change. To control for variation in local economic conditions, our counterfactual gas stations stem from the same district, but from a municipality that does not change the tax rate (i.e., we include district–year fixed effects). Recall there are about 11,000 municipalities (the level at which the tax rate varies) belonging to roughly 400 districts with an average area of 46 square miles (119 square kilometers), implying that treated and counterfactual gas stations are plausibly exposed to similar variation in local economic conditions. We also control for time-varying municipality characteristics (unemployment or cars per inhabitant) to account for differences in input prices and demand. Finally, we include gas station fixed effects.

Our empirical results show that gas prices are sensitive to local business tax rates. We find that a one percentage point increase in the local business tax rate increases gas prices, on average, by 0.1 euro cent per liter. Although this magnitude appears small relative to the average gas price of €1.39 per liter (around $5.90 per gallon) of E5 (gasoline with 5% ethanol), it is important to note that roughly 90% of the retail gas price is fixed (e.g., through energy taxes and input prices) and the profit margins are thin (e.g., two to three euro cents per liter). This main result is robust to the inclusion or exclusion of control variables, to using a first difference specification, and to using diesel fuel prices. Consistent with the parallel trends assumption underlying our approach, we also find that prices do not respond to future unanticipated tax rate changes.

To further sharpen the identification, we exploit a unique 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. This system essentially splits stations into four groups (two based on legal form, two based on the municipality's tax rate), of which one is unaffected by the tax. In line with this setup, we find that changes in the local business tax only affect prices in the three groups that should be directly affected based on the tax code. This analysis provides additional comfort in a causal interpretation of the result that corporate taxes lead to price increases, consistent with shifting of corporate taxes to consumers.

In the next step, we explore the heterogeneity in the extent to which local business taxes result in higher prices. We expect the relative elasticity of demand versus supply to be key in driving the extent to which consumers bear corporate taxes through higher prices. As demand elasticity is closely related to the intensity of competition or firms' market power (Lerner 1934), we exploit several conceptually related gas station and market characteristics such as gas stations operated by known brands, potentially exploiting consumer loyalty (e.g., Hastings 2004), and gas stations on highways or open around-the-clock (24/7), potentially exploiting inelastic demand. We also exploit local market characteristics, such as the intensity of competition. Finally, we exploit price differences across products at the same gas station with plausibly different consumer groups.

Our first set of tests exploits cross-sectional differences across gas stations *within* municipalities. That is, we include municipality–year fixed effects to account for all time-varying characteristics at the level at which tax rates are determined. We compare (1) gas stations located on a highway to regular gas stations, (2) renowned brand gas stations ("top brand"), and (3) gas stations open around-the-clock (24/7) versus other gas stations within a municipality and examine whether there is a difference in their responses to local business tax rate changes. Consistent with the notion that gas stations with less elastic consumer demand (highway, top brand, and 24/7 gas stations) are able to pass on more of the business tax to consumers, we find that the gas prices of highway, top brand, and 24/7 gas stations respond significantly more to business taxes.

Our second set of tests exploits local market characteristics. First, we exploit variation in the intensity of local competition. We compare the price response of gas stations facing more competitive local markets relative to gas stations located in the same district but in municipalities with less competitive local markets. We find that price increases resulting from increases in the tax rate are clustered in municipalities with less intense competition. Second, we show that gas stations located very close to each other (in sight) appear to coordinate their pricing to increase their market power. The price increase following a tax increase is greater if two gas stations are co-located (even compared to gas stations in the same municipality that are not close to each other). Finally, we exploit significant gas price differences along the German border. Gas prices in some bordering countries are significantly lower (e.g., Poland or Luxembourg) or higher (e.g., the Netherlands or Belgium) due to differences in energy taxes. In a subsample analysis of districts along the German border, we find that prices increase (remain the same) in districts sharing a border with a neighboring country that has higher (lower) gas prices when tax rates increase.

In the final step, we examine differences *within* gas stations *across* products. Diesel fuel is mostly consumed by business (e.g., trucks, delivery vans) and other frequent drivers who are more likely to actively choose gas stations based on prices (because it becomes cheaper than gasoline after a certain yearly mileage). Hence, we expect Diesel customers to be likely more elastic and find that gas stations pass on more of the tax to consumers in gasoline than in Diesel prices, even when including year-specific gas station fixed effects. The results indicate that the ability pass on the tax to consumers is also product-specific. Gas stations pass on more of the tax to consumers if demand elasticity for a specific product is lower.

In sum, we find that gas stations pass on corporate taxes to consumers and that gas stations facing less elastic demand pass more corporate taxes on to consumers. While these results are consistent with prior literature in that gas taxes are passed through to consumers (e.g., Marion and Mühlegger 2011), our results are novel because we exploit a profit tax (about which there is considerable debate on whether consumers bear it) and because we explore the heterogeneity in passing on taxes. Our results are thus related to the framework of all taxes, all parties (Scholes et al. 2015), where business transactions should consider all the tax consequences of all stakeholders. Our contribution is to provide direct evidence of how corporate taxes affect consumer prices.

While there is a large literature on how corporate taxes affect transfer prices (e.g., Grubert and Mutti 1991, Jacob 1996, Clausing 2003), our finding that corporate taxes affect product prices is novel and contributes to the tax avoidance[3] literature at the conceptual and measurement level. First, Fuest et al. (2018) and Dyreng et al. (2019) predict and find that the ability to shift taxes to employees (tax incidence) and the decision to reduce tax payments (tax avoidance) are substitutes. That is, tax incidence and tax avoidance are negatively associated. This substitutive relation is akin to the negative association between tax avoidance and the use of debt tax shields (e.g., Graham and Tucker 2006). Through this lens, the ability to shift taxes on to consumers provides firms with a non-debt tax shield. Accordingly, our findings highlight the role of the underlying product market and industry characteristics, e.g., a firm's market power, in determining tax incidence and therefore likely tax avoidance (e.g., Kubick et al. 2015). In a similar vein, we add to recent papers trying to explain why some firms operate with relatively high tax rates despite their access to tax avoidance opportunities such as multi-nationals with intangibles (e.g., Dyreng, Hanlon, and Maydew 2019). Since intangibles can give rise to market power (De Ridder 2019), our paper implies that such firms may face a lower corporate tax burden, which could explain their seemingly missing tax avoidance.

[3] Firms' ability to pass the tax burden likely can also affects trade-off underlying other decisions such as investments (e.g., Giroud and Rauh 2019, Dyreng et al. 2019) and capital structure choices (e.g., Heider and Ljungqvist 2015).

Second, our results also relate to the profit shifting literature (e.g., Grubert and Mutti 1991, Jacob 1996, Collins, Kemsley, and Lang 1998, Mills and Newberry 2004, Dyreng and Lindsey 2009, Klassen and Laplante 2012, De Simone 2016), which often uses pretax income and/or sales as key variables when measuring income shifting. Since the ability to pass on taxes affects the level of reported sales and, thus, pretax income (Gordon 1967), tax incidence likely influences profit shifting estimates. These estimates can be further affected due to heterogeneity in the ability to pass on taxes to consumers, in particular, when comparing estimates across firms (e.g., Dyreng and Markle 2016 for financial constraints) or over time (e.g., Klassen and Laplante 2012). Hence, for example, the interpretation of profit shifting trends (e.g., Dharmapala 2014) can benefit from exploiting other contemporaneous trends such as increasing industry concentration (e.g., Grullon et al., 2019), likely changing tax incidence.

In addition, our paper speaks to the literature on implicit taxes or tax capitalization (e.g., Berger 1993, Guenther 1994, or Erickson and Maydew 1998). Maydew (2001, p. 397) emphasizes that "tax capitalization viewed more broadly is a manifestation of the economic incidence of the tax." Hence, our results on the passing of taxes to stakeholders complements the implicit tax explanation for the positive relation between tax rates and pre-tax profits in Markle et al. (2019).

Finally, we contribute to the literature on corporate tax incidence (e.g., Fullerton and Metcalf 2002). We show that corporate taxes are (partly) borne by consumers (as also documented contemporaneously by Baker et al. 2019), not only by shareholders, low-skilled workers, and landowners (Suárez Serrato and Zidar 2016, Fuest et al. 2018). Our findings on tax incidence also relate to the tax policy debate. First, they highlight distributional effects of the corporate tax arising in the product market commonly ignored (e.g., by the Congressional Budget Office). Second, our paper reinforces the role of tax base properties for corporate tax incidence. Policies (e.g., as in the OECD/G20 BEPS project) broadening the tax base (e.g., limiting interest deductibility) to combat corporate tax avoidance may unintendedly give rise to the shifting of taxes to stakeholders.

2. Institutional setting, data, and empirical strategy

2.1 German local business tax

Business taxes in Germany depend on the legal form, generating two relevant groups that are affected by the local business tax. First, similar to C-corporations in the United States, incorporated firms (i.e., corporations) are taxed on their profits, and shareholders are taxed if dividends arise. On corporate profits, there is a federal tax of 15% and a local business tax. The local tax is levied at the municipality level. There are roughly 11,000 municipalities, and tax collections account for roughly 40% of municipalities' total revenues. Although the tax base of the local business tax is defined at the federal level, the municipality sets a multiplier that generates the variation we exploit. On average, the local component of a firm's tax burden is about 14% and, therefore, roughly half of a firm's nominal tax burden.

Second, unincorporated (e.g., partnership) firms' profits are passed through directly to their owners, to tax at the owner level (as the income of S-corporations in the United States). The local business tax, however, applies, since all commercial enterprises are subject to it. To achieve nominal tax burden equivalence between incorporated and unincorporated firms, the owners of unincorporated firms receive an income tax credit for local business taxes, up to 13.3%.[4] Local business taxes exceeding that level will become a true tax burden for these owners. We exploit this peculiarity, sorting unincorporated firms into unaffected firms (whose local business tax is less than or equal to 13.3%) and affected firms (whose local business tax is greater than 13.3%) in one test of our empirical strategy.

[4] Since the dividend tax rate in Germany amounts to 25%, corporation owners face a total tax burden on the distributed profits of 15% of the corporate tax and 14% of the local business tax and dividend tax. This amounts to 46.75% (= 15% + 14% + 25% (1 - 15% - 14%)). The profits of unincorporated businesses are subject to a marginal tax rate of up to 45%. For a local business tax rate of 14% and a tax credit of 13.3%, the total tax burden amounts to 45.7%. Note that this calculation neglects the so-called *solidarity surcharge* on corporate profits, dividends, and personal income.

2.2 Tax rate data and variation

We obtain the local business tax multipliers from the Federal Statistical Office of Germany (Destatis) for the 16 German federal states (see the Appendix for exact links to data sources). After merging the tax rate data with the municipality data and gas station prices, we obtain a sample of 4,507 municipalities. During our sample period, there were 1,691 changes in the local business tax rate larger than or equal to 0.25 percentage points. Of those changes, 1,650 were increases and 41 were decreases. The average increase in the local business tax rate was 0.8 percentage points, whereas the average decrease was 0.7 percentage points. Those changes occurred across Germany and among both urban and rural municipalities. Figure 1 shows all increases and decreases of more than 0.25 percentage point and of more than 1 percentage point. Figure 2, Panel A shows a map of German municipalities and the quintiles of the local business tax as well as a map that indicates municipalities changing the local business tax (Panel B). Finally, we note that, unlike in other institutional contexts, such as for state-level corporate taxes in the United States, the local business tax rate changes in Germany are isolated from changes in the tax base, since the tax base is determined at the federal level.

While potential endogeneity in local business tax rate changes is typically an issue, the German local business tax setting is somewhat unique. Tax rate changes are mostly politically motivated and carry more weight than economic shocks in decision making (Castanheira et al. 2012). Consistent with this notion, Foremny and Riedel (2014) show that the timing of elections affects local business tax changes, and Fuest et al. (2018) find that there are no local shocks to the business cycle prior to local business tax changes. We thus exploit changes in the local business tax in our empirical strategy.

2.3 Composition of gas prices in Germany

Our empirical strategy uses prices set by gas stations as a measure of consumer prices. The price of gas at gas stations comprises several elements. The main price driver for refined products (i.e., gas) is crude oil. Crude oil prices are usually stated in US dollars per barrel, determined by numerous factors on spot and future markets, such as oil quality and political circumstances. We consider it unlikely that the gas stations in our setting are driving crude oil prices. The crude oil market is characterized by highly monopolistic structures, dominated by the Organization of the Petroleum Exporting Countries (OPEC) cartel and US shale oil production, whereby 85% of production capabilities are owned by state-owned enterprises. Wholesale fuel prices in Germany are mostly determined by spot market prices in Amsterdam, Rotterdam, and Antwerp, plus costs for transportation and storage. Apart from spot prices, German domestic competition among gas stations, especially in a narrow local market, is accountable for fluctuations in gas prices. Since the 1990s, gas stations can change prices within seconds and respond to the actions of competitors immediately. Further, the Internet has facilitated timely price adjustments.

Another bulk part of the fuel price consists of taxes and duties per liter, where the numbers in parentheses are the average share of gross gas prices in 2017: there is the energy tax of €0.6545 (47.7%), the value-added tax (19%), and an oil stocking fee of 0.3 euro cents (0.2%), leaving fuel stations with a margin of 9.2%, on average, in 2017 (bft 2018). The total tax burden is €0.7789 on a liter of E5 and €0.5598 on a liter of diesel. Further cost factors are the euro–US dollar exchange rate, transportation costs, the leaseholder's salary, and capital expenditures (MWV 2006). The market transparency entity for fuel (*Markttransparenzstelle für Kraftstoffe*, abbreviated *MTS-K*) of the Federal Cartel Office's (*Bundeskartellamt*) finds that gas prices follow crude oil prices in general. Price cycles are becoming shorter and more pronounced, whereby gas stations next to highways disclose significantly higher prices but slower price cycles (*Bundeskartellamt* 2018).

Most of the gas stations' turnover stems from E5, diesel, and E10 gasoline.[5] Diesel is the cheapest fuel (because of lower energy taxes), followed by E10 and E5. In 2017, the spread between

[5] E10 is similar to E5 but consists of 10% anhydrous ethanol in addition to 90% gasoline.

E5 and E10 was constantly two to three euro cents per liter, whereas the spread between E5 and diesel was more volatile, ranging from 17 euro cents to 24 euro cents. Relevant factors for price differences across gas stations are ex-refinery prices as key input costs, a station's location (e.g., urban, industrial area, or highway), local competitive environment, and station-specific services and amenities, such as a car wash or a kiosk-type store (Haucap et al. 2017). However, although short-run fluctuations in gas prices do not appear to affect drivers' choice of gas station or the distance they subsequently drive, these do affect the amount of fuel purchased while refueling (Ritter et al. 2016).

Gas prices appear to be set in regional clusters by the top brand gas stations. In Figures A.1 and A.2 of the Online Appendix, we show that gas stations of the same top brand in the same district have a higher likelihood of simultaneously changing prices in a coordinated manner, relative to other gas stations. Gas stations of other brands tend to follow these prices changes with a delay of about an hour (see Figure A.3 of the Online Appendix). These two features suggest that (1) top brands centrally set prices in response to local costs and demand across their local stations, making it plausible for variation in local business taxes to enter their optimization, and (2) that smaller gas stations with presumably less sophisticated decision makers consider local business taxes in their pricing at least indirectly by following the (arguably more sophisticated) prices set by their regional top brand peer stations.

2.4 Gas price and station data

To obtain data on consumer prices, we exploit a unique data source. In Germany, since December 2013, all gas stations are required by law to report every price change to an entity of the Federal Cartel Office. This rich panel data comprise a census of retail prices for gasoline (E5 and E10, which differ in ethanol levels, with E5 being the most sold) and diesel for all gas stations in Germany. We use data ranging back to June 2014 to avoid known startup difficulties with the data.

Further, we drop negative and zero values for gas prices, as well as prices in the 0.01st and 99.99th percentiles of the respective gas prices.

Figure 3 presents a histogram of the gas prices for all observations (Panel A) and by year (Panel B). The retail prices are the nominal prices in euro cents per liter by fuel type for the consumer, including all taxes and duties. We compute the average price per year for each gas station. We note that the annual means and medians of the daily averages are very highly correlated (with a correlation coefficient above 0.98), such that we use only the average gas price per year in our regression analysis. We find that the prices for all three types of gasoline are (close to) normally distributed when we plot the distribution per year (Panel B).

Our empirical analysis is based on annual average price information (even though, given the data, we could in principle construct higher frequency measures). We choose this level since the local business tax rate is set annually. Once set by the local authorities, the tax rate is effective and persistent for one 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. For example, Fuest et al. (2018) and the concurrent working paper by Baker et al. (2019) aggregate their monthly wage (product price) data to annual data.[6] Second, by aggregating data to the annual level, we eliminate intermediate fluctuations (likely) unrelated to tax incidence. With a higher level of disaggregation, one could examine how quickly prices react to certain dynamics, but that question is different from our research question whether the business tax, on average, is passed on to consumers.

The data also comprise the name, brand, address, longitude and latitude, and a unique gas station ID. Brands can be grouped into groups based on their brand value and vertical integration. Haucap et al. (2017) differentiate among the oligopolistic players Aral (BP), Shell, Total, Esso

[6] We also note that using annualized data is common in finance and accounting even if high-frequency data such as daily stock prices or bid ask spreads are available (e.g., Daske et al. 2013, Amihud and Mendelson 2008, Amihud et al. 2015).

(ExxonMobil), and Jet (ConocoPhilipps); other integrated players Star (Orlen); Agip (ENI), HEM (Tamoil), and OMV; and other independent players and brands, such as Avia and bft. A group of stations that we label top brand, belonging to Aral, Shell, Esso, and Total, make up 41% of all observed gas stations. This separation seems feasible, since the Federal Cartel Office put a special focus on these brands in the final report of the sectoral investigation of fuels (*Bundeskartellamt* 2011). To examine differences in consumer demand elasticity, we further identify gas stations close to highways by utilizing ADAC data.[7] About 3% of gas stations are located on highways.

For further analyses, we obtain data on the legal form of gas stations from Creditreform. The data set consists of the address and respective legal form of the gas stations. Merging these data results in 7,103 unlimited liability firms (47% of the full sample) and 997 limited liability firms (6.6% of the full sample), with no available legal form for 7,011 gas stations. Using data from Google Places, we obtain information on the opening hours for 12,121 of our sample gas stations.

Based on information on the address, as well as longitudinal and latitudinal GPS coordinates, we identify the local municipalities in which the respective gas stations operate. For our main tests, we were able to allocate 15,111 gas stations to a single municipality.

2.5 Sample selection and descriptive statistics

Our initial sample contains 15,551 gas stations. Since we require information on all regional control variables and we need to uniquely assign gas stations to municipalities, we obtain a final sample of 15,111 gas stations (which represents more than 97% of all German gas stations) and 58,092 unique gas station–year observations over the period 2014–2017. We present an overview of our sample selection in Panel A of Table 1.

[7] We also hand-collected data by searching the gas stations' names for the German abbreviations related to highways (*Autobahn*, abbreviated, e.g., by *A* followed by the highway's number, or *BAB*). These gas stations also comprise gas stations located directly at highway exits.

Panel B of Table 1 presents summary statistics for gas prices, as well as municipality-level and gas station–level characteristics. On average, the price of a liter of regular fuel (E5) is €1.39 during our sample period, whereas the price of a liter of fuel with a higher portion of ethanol (E10) is €1.37. The lower average diesel price of €1.18 is mostly due to the lower energy tax for diesel. As mentioned above, 3% of our sample gas stations are located on a highway and 41% belong to top brand gas stations. The average local business tax rate is 13.85%, which increased steadily from 13.71% in 2014 to 13.96% in 2017. Table 1 also presents descriptive statistics on the characteristics of the municipalities in our sample. The median (average) municipality has 21,772 (190,680) inhabitants and 16,211 (94,558) registered cars. The number of gas stations in densely populated cities is very high, compared to the number of gas stations in sparsely populated regions.

Another implicit assumption in our identification approach is that prices are not set at a national level but there is variation in gas prices across regions and even within regions. As Fuest et al. (2018) argue, if prices are set at the national level, the corporate tax incidence should not fall on consumers. To assess this issue empirically, Figure 4 presents a histogram of daily average prices less the average gas price of stations in the same district on the same day. With a standard deviation of about 2.7 cents per liter (relative to an average margin of two to three cents per liter of gas), there is substantial variation in daily gas prices, even within very local areas.

2.6 Baseline regression

We use a generalized difference-in-differences design to identify the impact of the local business tax rate on fuel prices. The key idea is to compare the prices of gas stations in municipalities that experienced a change in local business tax to the prices of comparable gas stations located in a municipality that did not change its local business tax rate. To obtain a suitable control group, we include a fixed effects structure that narrows down the counterfactuals to geographically very close but unaffected municipalities. Specifically, we exploit the fact that multiple municipalities form a district and include district–year fixed effects. On average, 17.3 municipalities form a district, which results in the following estimation equation:

$$Gas\ Price_{i,t} = \alpha_0 + \beta_1 LBT_{j,t} + \gamma X_{j,t} + \alpha_i + \alpha_k \times \alpha_t + \varepsilon_{j,t} \quad (1)$$

where, for municipality *j* in year *t,* the dependent variable is *Gas Price,* the gas price of gas station *i* and *LBT* is the local business tax rate. In our tests, we use the average price of E5 because it is the most important type of gas in terms of turnover. In Tables A.1 and A.2 of the Online Appendix, we replicate our tests using the price of diesel and E10, with similar results. In our empirical tests, we use the price of E5 as well as its natural logarithm as alternative dependent variables.

Our main independent variable is *LBT*, the local business tax rate in municipality *j* in year *t*. If gas stations pass on the tax burden of the local business tax to consumers, β_1 is expected to be positive. We include district–year fixed effects ($\alpha_j \times \alpha_t$) to ensure that (1) our identification stems from changes in the local business tax and (2) our counterfactual gas stations are located in the same district. This way, we ensure that the counterfactual municipality is in the same district as the treated municipality. Since districts are very small, with an average area of 118.5 square kilometers (45.75 square miles), treated and control gas stations are subject to very comparable local economic conditions.[8]

In our regression analysis, we include gas station fixed effects (α_i) and control for multiple controls for local economic conditions and demand for gas stations, as expressed by the vector *X*. The control variables include the number of cars, the number of gas stations per car, and the unemployment rate for municipality *j* in year *t*.[9] These local controls and, in particular,

[8] With this specification, municipalities that are also districts (e.g., Berlin, Munich, Hamburg, Cologne, and Frankfurt) do not identify the coefficient. In alternative specifications, we therefore use less restrictive state–year fixed effects so that cities that are a municipality also contribute to the identification of the *LBT* coefficient.

[9] We collect data from the annual municipality report of the Federal Statistics Office. The municipalities in our sample are defined by their boundaries as of 2017 and can be constantly observed over the sample period. In other words, there was no major regrouping or merger of municipalities. The data set contains information on the area (in square kilometers), the population, the GPS coordinates of the municipality's geographic midpoint, the municipality's hinterland, and the degree of urbanization. Further, data regarding the number of cars per municipality and year are obtained from the Federal Motor Transport Authority (*Kraftfahrt-Bundesamt*).

unemployment are also aimed at accounting for demand effects at the local level. Our statistical inference is based on robust standard errors clustered at the municipality level.

Our identification strategy rests on some assumptions, for example, that the tax changes are exogenous and that gas stations do not change prices in anticipation of tax changes. We take several steps in our empirical analysis to support our baseline model. First, we test whether gas prices respond to future tax rates, to test for parallel trends. Second, we exploit the institutional features of the German tax system, where firms, depending on the legal form and the tax rate, are either affected or unaffected by the local business tax. Third, we exploit different cross-sectional tests that exploit differences in consumer demand elasticity. In these tests, we can include municipality–year fixed effects to account for variation in municipality-specific local conditions that could affect taxes and/or gas prices.

3 Empirical results

3.1 German local business tax and gas prices

We first examine how business tax relates to gas prices, measured by the price of one liter of E5. Table 2 reports the regression results from estimating equation (1). Recall that all the analyses include gas station fixed effects. Panel A includes state–year fixed effects, so that all municipalities, including bigger cities, identify the *LBT* coefficient. In Panel B, we include district–year fixed effects to narrow down the counterfactual gas stations to municipalities without a tax rate change located in the same district. We present the results without controls (columns (1) and (2)) and with controls (columns (3) and (4)) for the price of one liter of E5 (columns (1) and (3)) and the natural logarithm of the price per liter (columns (2) and (4)).

The results of Table 2, Panels A and B, 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 eight specifications. Further, the inclusion of control variables or the choice of the fixed effects structure does not change the inferences. In terms of economic significance, a one percentage point increase in the local business tax rate raises the E5 price by 0.107 euro cents per liter, using the coefficient estimate from Panel B, column (4). Although this magnitude appears low, particularly relative to the average E5 price of €1.39 per liter, recall that the vast majority (about 90%) of the retail E5 price is de facto fixed. Profit margins on gasoline are thin (around two to three euro cents per liter). Hence, relative to a margin of three cents per liter, the elasticity of the margin with respect to the local business tax rate is 0.49.[10] We also note that the coefficients of the control variables are all as expected, but insignificant, except for the lagged unemployment rate, which is negatively related to the E5 price.

In the final step, we examine a first-difference version of equation (1). First differencing has the advantage of better facilitating multiple changes per municipality. As before, it also removes any firm-, state-, district-, or municipality-specific fixed effect. Panel C of Table 2 reports the regression results for *LBT* from the change model. Again, we estimate the regression without controls (columns (1) and (2)) and with controls (columns (3) and (4)) for both the price of one liter of E5 (columns (1) and (3)) and its natural logarithm (columns (2) and (4)). The results are very similar to our main results in Panel B of Table 2 and support the notion that firms pass on corporate taxes to consumers.

We subject our results to two robustness tests. First, one potential source of endogeneity of local business tax rates is that they change because the municipality has financing needs. To account for the municipality's potential local financing needs driving our results, we add as a control variable the local property tax, which is another main source of funding for municipalities and that is set at the municipality level. In column (1) of Table A.3 in the Online Appendix, we show that, for the price of E5 (Panel A) as well as its natural logarithm (Panel B), the coefficient

[10] This is calculated as the margin's percent increase of 3.6% (= 0.107/3), divided by the percent increase in the tax rate relative to the sample mean of 7.2% (= 1%/13.85%).

of *LBT* is very similar to our baseline estimate, suggesting that the local funding needs of municipalities are unlikely to explain the effect of business taxes on E5 prices. Second, we address the concern that the relation between our control variables for the local economic environment and E5 prices could vary over time and across regions. For example, the economic structure differs between the east and west of Germany. To address this concern, we interact all the control variables with year fixed effects to allow the coefficients of the control variables to vary over time (column (2)), interact all the control variables with state fixed effects to allow the coefficients of the control variables to vary spatially (column (3)), and combine both approaches (column (4)). We continue to find a positive effect of local business taxes on E5 prices, with very similar magnitudes as the main results.

3.2 Parallel trends assumption

We next test whether there are any anticipation effects, which would invalidate the parallel trends assumption. Table 3 presents the regression results of estimating the change specification from Panel C, Table 2, where we add two leads for change in the local business tax rate as the independent variable. Following the previous analyses, we do not include controls variables in columns (1) and (2), whereas we do in columns (3) and (4). The results show no anticipation effect. The coefficients on the change in the tax rates in the next two years are statistically insignificant. Instead, E5 prices increase in response to a higher local business tax rate in year *t*. Only the coefficient of the current change in the local business tax rate is positive and statistically different from zero at the 1% level in all specifications. The results in Table 3 thus suggest that the parallel trends assumption seems to hold in our setting.

3.3 Identification: Exploiting differences in organizational form

In the next step, we address remaining concerns that unobserved local economic conditions or the need for local amenities are driving both 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 any credit for the local business tax. This feature provides us with a subsample of gas stations unaffected by local business tax changes. We therefore augment equation (1) and estimate the model

$$Gas\ Price_{i,t}=\alpha_0+\beta_1 LBT_{j,t}+\beta_2 LBT_{j,t}\times Affected_{i,t}+\beta_3 Affected_{i,t}+\gamma X_{j,t}+\alpha_i+\alpha_j\times\alpha_t+\varepsilon_{j,t} \quad (2)$$

where all the variables are defined as in equation (1). We additionally interact *LBT* with *Affected*, which is a dummy equal to one if the gas station is either an unincorporated firm subject to a local business tax rate above 13.3% in year *t* or if the gas station is an incorporated firm. The dummy *Affected* is zero for all unincorporated firms subject to a local business tax rate of 13.3% or lower in year *t*, since owners receive a credit for the full local business tax and it is, thus, irrelevant to them. These firms should not respond to local business tax changes. In our setup, β_1 captures the effect of a change in the local business tax for gas stations that receive a tax credit. Hence, we expect the β_1 coefficient to be zero. The β_2 coefficient captures the incremental effect for gas stations that are, according to the tax code, affected by local business tax changes. Hence, we would expect the β_2 coefficient to be positive. Further, the overall effect of a change in the local business tax on E5 prices is captured by the sum of the β_1 and β_2 coefficients. We expect the sum to be positive and significantly different from zero, consistent with the notion that affected gas stations pass on business taxes to customers.

We report the results of estimating equation (2) in Panel A of Table 4. Columns (1) and (2) do not include controls variables, whereas columns (3) and (4) include controls for both the price of one liter of E5 (columns (1) and (3)) and its natural logarithm (columns (2) and (4)). The results support our predictions. The main effect of *LBT*—the effect of a change in *LBT* for unaffected gas stations—is small and insignificant. Further, the interaction of *LBT* and *Affected* is positive and significant at the 1% level, suggesting that affected gas stations' E5 prices are sensitive to local business tax changes. The coefficient of the local business tax rate on the E5 price is positive and significantly different from zero at the 1% level for affected gas stations (denoted *LBT* × *Affected*).

The joint significance test (denoted *LBT* + *LBT* × *Affected*) is also positive, consistent with our findings in Table 2.

In Panels B and C of Table 4, we take this analysis one step further and split the group of affected gas stations into three subgroups: (1) unincorporated gas stations with an *LBT* value above 13.3%, (2) incorporated gas stations with an *LBT* below 13.3%, and (3) incorporated gas stations with an *LBT* of above 13.3%. We contrast these three groups with unaffected gas stations using the approach from equation (2), but with additional interactions for the respective subgroups. The results for the level (logarithm) of E5 are reported in Panel B (Panel C). In the *LBT* row, we report the (overall) effect *LBT* has on E5 prices in the respective subgroup. We also report (in italics) whether the difference in prices between groups is statistically significant. As expected, we find *LBT* has a insignificant effect among unaffected gas stations (column (1)) and significantly positive results for affected gas stations, as shown in columns (2) to (4). Importantly, the coefficient from column (1) (for gas stations with a local business tax rate below 13.3%) is significantly different from the coefficients for affected gas stations (reported in columns (2) to (4)). The remaining differences, that is, the differences between the three subgroups of affected gas stations, are not statistically significant. This result is consistent with our main prediction: when the local business tax is a burden, gas stations—irrespective of their legal form—pass on the burden to consumers in the form of higher prices.

4 Taxes and consumer prices: The role of relative elasticities of demand and supply

In this section, we explore the heterogeneity in the extent to which local business taxes affect consumer prices. Theory suggests that the relative elasticity of demand vis-à-vis supply is a key variable driving the extent to which consumers bear the corporate tax burden. In the following, we operationalize this notion by exploiting gas station characteristics (Section 4.1) and local market characteristics (Section 4.2). In all these cross-sectional analyses, we expect to find evidence of a greater effect of taxes on E5 prices when gas stations' supply elasticity is lower relative to consumer demand elasticity.

4.1 Exploiting gas station characteristics

Our first set of tests exploits gas station characteristics. One limitation of our data is that we do not observe the financial information of gas stations. Still, we are able to obtain some information that enables us to split gas stations into those with more versus less market power relative to their customers. First, we argue that gas stations located on a highway (*Autobahn*) face relatively inelastic consumers (Haucap et al. 2017). Highway gas stations benefit from barriers to entry, which provide them with market power over consumers (McAfee et al. 2004). To empirically validate the assumption that highway gas stations can charge higher gas prices, we plot in Panel A of Figure 5 the average daily E5 prices (demeaned by the average price in a given day in the respective district) for highway versus regular gas stations. Consistent with our assumption that highway gas stations have more market power, we find that, on average, highway gas stations can charge 4.7 cents more per liter relative to their local competitors on that day.

To test whether highway gas stations also pass on more of the business tax to consumers, we augment equation (1) by interacting *LBT* with *Highway*, which is a dummy variable equal to one if a gas station is located in immediate proximity to a highway. The main effect of *Highway* is absorbed by gas station fixed effects. Further, we include municipality–year fixed effects. Effectively, our regression now compares each highway gas station with another gas station *within* the same municipality to estimate how the local business tax translates into gas prices. The coefficient of LBT × Highway measures the difference in the passing on of business taxes to consumers between highway and regular gas stations. The results are reported in Table 5, columns (1) and (2). The positive and significant coefficient of *LBT* × *Highway* is consistent with our prediction that, when a gas station faces relatively inelastic consumers, it passes on more of the business tax burden to them.

Second, we exploit consumer brand loyalty (Hastings 2004). For top brand gas stations, customers tend to be loyal to a particular brand, lowering their demand elasticity. For example, Bronnenberg et al. (2012) find that consumers' brand preferences are highly persistent, and Bronnenberg et al. (2015) find consumers pay substantial premiums. Further, due to local coordination of gas prices across gas stations of the same brand within the same district (see Figure A.1 of the Online Appendix), top brand gas stations can exert more market power.

As described above, we define *Top Brands* as Aral, Shell, Esso, and Total gas stations. To support the general assumption of a brand premium, we show in Panel B of Figure 5 that top brand gas stations have a higher average daily price compared to their local non-top brand peers. We then follow the approach for highway gas stations, but include the interaction of *LBT* with the *TopBrand* dummy. Again, we include municipality–year fixed effects to compare regular gas stations to top brand gas stations within the same municipality. In columns (3) and (4), we present the regression results for *LBT* × *Top Brand*. Consistent with our prediction, we find that greater the pass through of the local business tax to consumers among top brand stations. The coefficients are significantly positive at the 1% level.

Third, we exploit differences in opening hours. Some gas stations close at some point during the night, providing the remaining gas stations that are always open (24/7 gas stations, denoted by the dummy *24/7*) temporarily with more market power. To support this claim empirically, Panel C of Table 5 compares demeaned gas prices between 24/7 gas stations and other gas stations. We find that, relative to their peers in the district, 24/7 gas stations, on average, charge 1.4 euro cents more per liter. We then follow our approach from above and interact the dummy *24/7* with *LBT*. Columns (5) and (6) present the regression results for *LBT* × *24/7*. As expected, we find that gas stations that are open around the clock (i.e., *24/7* = 1) pass on more of the local business tax burden than other gas stations, consistent with the idea that 24/7 gas stations temporarily have more market power when other gas stations are closed. Overall, the three heterogeneity tests support the notion that gas stations with relatively high market power vis-à-vis their customers can pass on more of their business taxes to consumers.[11]

4.2 Exploiting market characteristics: The role of (local) competition

In the second step, we examine the role of local competition. If gas stations face more (less) competition, we expect them to be less (more) able to pass on the corporate tax to customers. We operationalize this notion conceptually by combining proxies for low demand (proxied by the number of cars per inhabitants) and high supply (proxied by the number of gas stations per inhabitant) at the same time. Specifically, we define a dummy variable *High Competition,* which is equal to one if the municipality is characterized by low demand (i.e., the municipality is below the median of the cars per inhabitant distribution) and high supply (i.e., the municipality is above the median of the gas stations per inhabitant distribution). The combination of low demand and high supply results in high local competition.

Following our approach from the firm-level heterogeneity tests, we then interact *High Competition* with *LBT* and also include the main effect. Table 6 presents the results. In columns (1) and (2) we use the entire sample, and in columns (3) and (4) we exclude municipalities with low competition (i.e., with above-median demand *and* below-median supply). Consistent with our prediction, we find that the main effect on *LBT* is positive and significant, suggesting that, in municipalities without high competition (*High Competition = 0*), gas stations pass on a higher share of their tax burden to consumers. The negative interaction of *High Competition* × *LBT* shows that gas stations operating in highly competitive markets are less able to pass on taxes to consumers. In fact, since the coefficients of *LBT* and *High Competition* × *LBT* are jointly insignificant, gas stations in highly competitive local markets are unable to pass on any of the local business tax.

[11] In untabulated analyses, we include all three characteristics at the same time to address concerns that these three characteristics are highly correlated. When including all interactions at the same time, we continue to find all interactions to be statistically significant.

We further explore the role of local competition by examining whether gas stations that are geographically very close together coordinate their pricing to increase their combined market power vis-à-vis customers. Hence, instead of competing, these gas stations could coordinate price adjustments (*Bundeskartellamt* 2011). When comparing the average daily prices (demeaned) in the district, we find in untabulated tests that, relative to other gas stations in the same district, gas stations that are very close together charge, on average, 0.5 cents more per liter. To test empirically whether geographically close gas stations also pass on more of the local business tax, we interact *LBT* with a dummy variable *Very Close*, which is a dummy variable equal to one if there is, within the same municipality, another gas station with a respective distance below the 25th percentile of the minimum distance to the next gas station within the same municipality of the whole sample. That is, the average distance *Very Close* is 146 meters (160 yards), with a maximum of 315 meters (344 yards). Table 7 presents the regression results using either district–year fixed effects (columns (1) and (2)) or municipality fixed effects (columns (3) and (4)). We find that the interaction between *LBT* and *Very Close* is positive and statistically significant in all specifications. This result suggests that gas stations that are geographically very close coordinate their pricing so that they can pass on more of the local business tax to customers.

Finally, as further support for our prediction that the relative elasticity of supply and demand is driving the ability of gas stations to pass on the local business tax, we exploit cross-country differences in E5 prices. Germany shares borders with nine countries. In four of these countries (Austria, the Czech Republic, Luxembourg, and Poland), E5 is cheaper, which makes Germans and foreigners at the border more elastic at German gas stations; that is, customers are encouraged to buy outside Germany. In contrast, in five countries (Belgium, Denmark, France, the Netherlands, and Switzerland), E5 is more expensive, making German gas stations relatively more elastic, because they do not face fierce competition from abroad. We therefore create a dummy variable *High Price Abroad* that equals one if the district shares a border with Belgium, Denmark, France, the Netherlands, or Switzerland, and zero if the district shares a border with Austria, the Czech Republic, Luxembourg, or Poland.[12] Districts without a border are excluded from this test. We then interact *High Price Abroad* with *LBT* and include controls and gas station and year fixed effects.

Table 8 reports the results. The main effect of *LBT* estimates the effect in districts that share a border with a country with lower E5 prices. The insignificant coefficient suggests that, in these districts—because of the local competition from abroad—German gas stations cannot pass on the local business tax. In contrast, the *High Price Abroad* × *LBT* coefficient is positive and significant, suggesting that a higher local business tax rate results in higher E5 prices in districts that share a border with a country where E5 is more expensive than in Germany. Collectively, our cross-sectional tests show that the average effect of corporate tax increases on consumer prices is a function of the elasticity or market power of the firm: gas stations pass on more of the local business tax to relatively inelastic consumers and when they have market power.

4.3 Exploiting product characteristics: Diesel versus gasoline

In the final step, we examine the role of product characteristics and differentiation. Consumers' price elasticity of demand hinges on product-specific characteristics. We argue that Diesel fuel is mostly consumed by businesses (e.g., trucks, delivery vans) and other frequent drivers. These drivers are more likely to actively choose gas stations based on prices. For example, logistics companies apply sophisticated route planning and algorithms to minimize costs. As fuel is their main cost driver, they actively look for savings potential by choosing cheap gas station or buy gas at specific times. Further, diesel vehicles are more expensive initially, but become cheaper than gas vehicles after a certain mileage. Hence, we expect Diesel consumers to be more price sensitive and likely more elastic. Put differently, we expect that the effect of local business taxes is higher on gasoline prices (=E5) than on Diesel prices.

[12] One district shares a border with Luxembourg and France, and another shares a border with Luxembourg and Belgium. We treat these districts as having a border with a low-price environment, due to access to Luxembourg.

The empirical test of this prediction uses the fact that we observe gas prices for E5 and Diesel for each gas station. The dependent variable *Price* is then either the E5 price or the Diesel price. Hence, each gas station enters the regression twice, once with its E5 price and once with its Diesel price. We then run our baseline model and include a dummy variable *E5* which is equal to one if *Price* is the price of E5 as well as an interaction of *E5* with *LBT*. The results are shown in Table 9.All regressions include municipality-year fixed effects. In columns (3) and (4), we further include gas station-year fixed effects to absorb any time-varying gas station characteristic such as profitability (unobservable for us). The positive and significant *LBT* × *E5* interaction is consistent with the prediction that because Diesel drivers are more elastic, more of the local business tax is passed on to consumers of gasoline. The results thus indicate that the ability to pass on the tax to consumers is also product-specific. This result holds even when including year-specific gas station fixed effects. Thus, we conclude that gas stations pass on more of the tax to consumers if demand elasticity for a specific product is lower.

5 Conclusion

In this paper, we examine whether consumers bear the corporate tax burden in the form of higher prices. Using census data on the gas prices of 15,111 German gas stations and local variation in business tax rates in 4,507 municipalities, we examine the effect of local business taxes on consumer prices while controlling for local economic conditions. Our results show that higher business taxes increase consumer prices. Hence, part of the corporate tax incidence appears to fall on consumers. We further show that the effect of business taxes on gas prices increases if consumers are less elastic and when gas stations have greater market power.

Our results have implications not only for policymakers and the public debate, but also for the academic literature. Passing on corporate taxes to consumers is an alternative way of creating a tax shield. Hence, firm decisions on investment (e.g., Djankov et al. 2010, Giroud and Rauh 2019), capital structure (e.g., Heider and Ljungqvist 2015), and tax avoidance (e.g., Dyreng et al. 2019) are potentially affected by the ability to pass on taxes to consumers following the all taxes, all parties framework of Scholes et al. (2015), according to which the evaluation of transactions should consider the tax consequences of all stakeholders involved. We show that corporate taxes can be passed on to consumers in the form of higher prices, shifting the incidence of the tax away from the firm. How firms' tax sensitivity of investment and capital structure varies, with the ability to pass on corporate taxes to consumers (or workers), is a potential avenue for future research. However, we also note that our paper has certain limitations. For example, we focus on one specific market with a homogeneous necessity good. How and whether our results are generalizable to other goods and industries is left for future research.

Keeping these limitations in mind, our findings are important for the tax policy debate, in which equity considerations feature prominently. Our results suggest that increasing corporate taxes does not only affect capital owners and low-skilled workers, but also consumers through higher product prices. Our results also relate to the ongoing debate surrounding the OECD BEPS project. Several countries have introduced tax code features aimed at curbing tax avoidance, for example, limits to the interest deductibility. Since the passing of taxes to consumers are, in theory, rooted in exactly such tax base broadening measures that limit the deductibility of investment costs, our results suggest that additional limits in the deductibility of investment costs (e.g., the limited interest deductibility or the limited loss offset rules as part of the Tax Cuts and Jobs Act 2017 in the U.S.) could result in a larger share of the corporate tax being passed on to other stakeholders. Since our setting does not include tax base differences across municipalities or over time, we cannot directly test this notion and leave this question for future research.

References

Amihud, Y., Hameed, A., Kang, W., and Zhang, H. (2015): The illiquidity premium: International evidence. *Journal of Financial Economics*, 117(2), 350–368.

Amihud, Y., and Mendelson, H. (2008): Liquidity, the value of the firm, and corporate finance. *Journal of Applied Corporate Finance*, 20(2), 32–45.

bft (2018): *Branchenstudie Tankstellenmarkt Deutschland 2017*.

Baker, S. R., Sun, S. T., and Yannelis, C. (2019): Corporate Taxes and Retail Prices. NBER Conference Papers. Available at: https://conference.nber.org/conf_papers/f130227.pdf.

Berger, P. G. (1993): Explicit and implicit tax effects of the R&D tax credit. *Journal of AccountingRresearch*, 31(2), 131–171.

Brekke, K.R., Garcia Pires, A.J., Schindler, D., and Schjelderup, G. (2017): Capital Taxation and Imperfect Competition: ACE vs. CBIT. *Journal of Public Economics*, 147, 1–15.

Bronnenberg, B. J., Dubé, J.-P. H., Gentzkow, M., and Shapiro, J.M. (2015): Do Pharmacists Buy Bayer? Informed Shoppers and the Brand Premium. *Quarterly Journal of Economics*, 130(4), 1669–1726.

Bronnenberg, B. J., Dubé, J.-P. H., and Gentzkow, M. (2012): The Evolution of Brand Preferences: Evidence from Consumer Migration. *American Economic Review*, 102(6), 2472–2508.

Bundeskartellamt (2011): *Sektoruntersuchung Kraftstoffe: Abschlussbericht gemäß § 32e GWB – Mai 2011*.

Bundeskartellamt (2018): *Markttransparenzstelle für Kraftstoffe (MTS-K): Jahresbericht 2017*.

Cabral, L.M.B. (2017): *Introduction to Industrial Organization,* second edition. The MIT Press, Cambridge, Massachusetts.

Castanheira, M., Nicodème, G., and Profeta, P. (2012): On the Political Economics of Tax Reforms: Survey and Empirical Assessment. *International Tax and Public Finance*, 19, 598–624.

Clausing, K. A. (2003): Tax-motivated transfer pricing and US intrafirm trade prices. *Journal of Public Economics*, 87(9-10), 2207–2223.

Collins, J., Kemsley, D., and Lang, M. (1998): Cross-jurisdictional income shifting and earnings valuation. *Journal of Accounting Research*, 36(2), 209–229.

Daske, H., Hail, L., Leuz, C., and Verdi, R. (2013): Adopting a label: Heterogeneity in the economic consequences around IAS/IFRS adoptions. *Journal of Accounting Research*, 51(3), 495–547.

Dharmapala, D. (2014): What do we know about base erosion and profit shifting? A review of the empirical literature. *Fiscal Studies*, 35(4), 421–448.

De Ridder, M. (2019): Market Power and Innovation in the Intangible Economy, Working Paper.

De Simone, L. (2016): Does a common set of accounting standards affect tax-motivated income shifting for multinational firms?. *Journal of Accounting and Economics*, 61(1), 145–165.

Djankov, S., Ganser, T., McLiesh, C., Ramalho, R., and Shleifer, A. (2010): The Effect of Corporate Taxes on Investment and Entrepreneurship. *American Economic Journal: Macroeconomics*, 2, 31–64.

Dyreng, S. D., Hanlon, M., and Maydew, E. L. (2019): When Does Tax Avoidance Result in Tax Uncertainty? *The Accounting Review*, 94(2), 179–203.

Dyreng, S. D., Jacob, M., Jiang, X., and Müller, M. A. (2019): Tax Incidence and Tax Avoidance. *SSRN Working Paper*.

Dyreng, S. D., and Lindsey, B. P. (2009): Using financial accounting data to examine the effect of foreign operations located in tax havens and other countries on US multinational firms' tax rates. *Journal of Accounting Research*, 47(5), 1283–1316.

Dyreng, S. D., and Markle, K. S. (2016): The effect of financial constraints on income shifting by US multinationals. *The Accounting Review*, 91(6), 1601–1627.

Erickson, M. M., and Maydew, E. L. (1998): Implicit taxes in high dividend yield stocks. *The Accounting Review*, 73(4), 435–458.

Foremny, D., and Riedel, N. (2014): Business Taxes and the Electoral Cycle. *Journal of Public Economics*, 115, 48–61.

Fuest, C., Peichl, A., and Siegloch, S. (2018): Do Higher Corporate Taxes Reduce Wages? Micro Evidence from Germany. *American Economic Review*, 108, 393–418.

Fullerton, D., and Metcalf, G. (2002): Tax Incidence. In Auerbach, A.J., and Feldstein, M. (Eds.), *Handbook of Public Economics*, Vol. 4, first ed. Elsevier, pp. 1787–1872.

Giroud, X., and Rauh, J. (2019): State Taxation and the Reallocation of Business Activity: Evidence from Establishment-Level Data. *Journal of Political Economy*, 127, 1262–1316.

Gordon, R. J. (1967): The Incidence of the Corporation Income Tax in U.S. Manufacturing, 1925-62. *American Economic Review*, 68, 731–758.

Graham, J. R., and Tucker, A. L. (2006): Tax shelters and corporate debt policy. *Journal of Financial Economics*, 81(3), 563–594.

Gravelle, J. (2013): Corporate Tax Incidence: Review of General Equilibrium Estimates and Analysis. *National Tax Journal*, 66, 185–214.

Gruber, J. (2016): *Public finance and public policy*, Fifth edition. Worth Publishers, New York, NY.

Grubert, H., and Mutti, J. (1991): Taxes, tariffs and transfer pricing in multinational corporate decision making. *Review of Economics and Statistics*, 285–293.

Grullon, G., Larkin, Y., and Michaely, R. (2019): Are US industries becoming more concentrated?. *Review of Finance*, 23(4), 697–743.

Guenther, D. A. (1994): The relation between tax rates and pre-tax returns Direct evidence from the 1981 and 1986 tax rate reductions. *Journal of Accounting and Economics*, 18, 379–393.

Harberger, A. C. (2008): Corporation Tax Incidence: Reflections on What Is Known, Unknown, and Unknowable. In Diamond, J.W., and Zodrow, G.R. (Eds.), *Fundamental Tax Reform*. The MIT Press, Cambridge, Massachusetts, pp. 282–307.

Hastings, J. S. (2004): Vertical Relationships and Competition in Retail Gasoline Markets: Empirical Evidence from Contract Changes in Southern California. *American Economic Review*, 94, 317–328.

Haucap, J., Heimeshoff, U., and Siekmann, M. (2017): Fuel Prices and Station Heterogeneity on Retail Gasoline Markets. *The Energy Journal*, 38.

Heider, F., and Ljungqvist, A. (2015): As Certain as Debt and Taxes: Estimating the Tax Sensitivity of Leverage from State Tax Changes. *Journal of Financial Economics*, 118, 684–712.

Jacob, J. (1996). Taxes and transfer pricing: Income shifting and the volume of intrafirm transfers. *Journal of Accounting Research*, 34(2), 301-312.

Klassen, K. J., and Laplante, S. K. (2012): Are US multinational corporations becoming more aggressive income shifters? *Journal of Accounting Research*, 50(5), 1245–1285.

Kubick, T. T., Lynch D. P., Mayberry M. A., and Omer, T. C. (2015): Product market power and tax avoidance: Market leaders, mimicking strategies, and stock returns. *The Accounting Review*, 90, 675–702.

Lerner, A. P. (1934): The Concept of Monopoly and the Measurement of Monopoly Power. *Review of Economic Studies*, 1, 157–175.

Marion, J., and Mühlegger, E. (2011): Fuel Tax Incidence and Supply Conditions. *Journal of Public Economics*, 95, 1202-1212.

Markle, K., Mills, L. F., and Williams, B. (2019): Implicit Corporate Taxes and Income Shifting. *The Accounting Review*, forthcoming.

Maydew, E. L. (2001). Empirical tax research in accounting: A discussion. *Journal of Accounting and Economics*, 31(1-3), 389-403.

McAfee, R. P., Mialon, H.M., and Williams, M.A. (2004): What Is a Barrier to Entry? *American Economic Review,* 94(2), 461–465.

Mills, L. F., and Newberry, K. J. (2004): Do foreign multinationals' tax incentives influence their US income reporting and debt policy? *National Tax Journal*, 57, 89–107.

MWV (2006): *Preisbildung an Tankstellen*. Available at: https://www.mwv.de/wp-content/uploads/2016/07/mwv-publikationen-broschuere-Preisbildung-an-tankstellen-2006.pdf (accessed 06 August 2019).

MWV (2019): *Preiszusammensetzung*. Available at: https://www.mwv.de/statistiken/preiszusammensetzung/ (accessed 06 August 2019).

Poterba, J.M. (1996): Retail Price Reactions to Changes in State and Local Sales Taxes. *National Tax Journal*, 49, 165–176.

Ritter, N., Schmidt, C. M., and Vance, C. (2016): Short-Run Fuel Price Responses: At the Pump and on the Road. *Energy Economics*, 58, 67–76.

Scholes, M. S., Wolfson, M. A., Erickson, M. M., Hanlon, M. L., Maydew, E. L., and Shevlin, T. (2015): *Taxes and Business Strategy: A Planning Approach, Always Learning,* fifth edition, Pearson.

Sebold, F. D. (1979): The Short-Run Shifting of the Corporation Income Tax: A Simultaneous Equation Approach. *Review of Economics and Statistics*, 61, 401.

Slemrod, J., and Yitzhaki, S. (2002): Tax avoidance, evasion, and administration. In *Handbook of Public Economics* (Vol. 3, pp. 1423–1470). Elsevier.

Suárez Serrato, J. C., and Zidar, O. (2016): Who Benefits from State Corporate Tax Cuts? A Local Labor Markets Approach with Heterogeneous Firms. *American Economic Review*, 106, 2582–2624.

Total (2017): *Informationen zur Benzinpreis-Zusammensetzung*. Available at: http://www.total.de/kraftstoffe/kraftstoffwissen/kraftstoffpreise.html (accessed 06 August 2019).

Vasquez-Ruiz, H. A. (2012): A New Approach to Estimate the Incidence of the Corporate Income Tax. Dissertation, Georgia State University.

Appendix: Variable definitions

Gas station–level variables		Source
E5	The price for one liter of regular gasoline with 5% ethanol.	Tankerkönig (https://creativecommons.tankerkoenig.de)
E10	*E10* is the price for one liter of gasoline with 10% ethanol.	Tankerkönig (https://creativecommons.tankerkoenig.de)
Diesel	*Diesel* is the price for one liter of diesel fuel.	Tankerkönig (https://creativecommons.tankerkoenig.de)
Highway	*Highway* is a dummy variable equal to one if the gas station is located in direct proximity to a highway.	ADAC (https://www.adac.de/_mmm/pdf/Online-Liste-Tanken-auf-Reisen-2018-07_51818.pdf)
Affected	*Affected* is a dummy variable that equals one if the gas station is either an incorporated company or an unincorporated firm facing a local business tax rate above 13.3%.	Federal Statistical Office of Germany (https://www.destatis.de/DE/Themen/Staat/Steuern/Steuereinnahmen/_inhalt.html#sprg245508)
Incorporated	*Incorporated* is a dummy variable equal to one if a gas station is set up as an incorporated firm (e.g., corporation or limited liability company).	Creditreform
Unincorporated	*Unincorporated* is a dummy variable equal to one if a gas station is set up as an unincorporated firm (e.g., a partnership or sole proprietorship).	Creditreform
Top Brand	*Top Brand* is a dummy variable equal to one if a gas station belongs to the brands Aral, Shell, Esso, or Total, the best-known brands in Germany.	Tankerkönig (https://creativecommons.tankerkoenig.de/)
24/7	*24/7* is a dummy variable equal to one if the gas station is open 24 hours and seven days a week.	Google Data (www.google.com)
High Competition	*High Competition* is a dummy variable equal to one if the municipality is characterized by low demand (i.e., the municipality is below the median of the cars per inhabitant distribution) and high supply (i.e., the municipality is above the median of the gas stations per inhabitant distribution).	Own calculation with other data retrieved
Very Close	*Very Close* is a dummy variable equal to one if another gas station is in immediate proximity to the respective gas station.	Federal Agency for Cartography and Geodesy (http://www.geodatenzentrum.de/geodaten/gdz_rahmen.gdz_div?gdz_spr=eng&gdz_user_id=0)

High Price Abroad	*High Price Abroad* is a dummy variable that equals one if the district shares a border with Belgium, Denmark, France, the Netherlands, or Switzerland, and zero if the district shares a border with Austria, the Czech Republic, Luxembourg, or Poland.	Allgemeiner Deutscher Automobil-Club (ADAC) (English translation: *General German Automobile Club*) (https://www.adac.de/verkehr/tanken-kraftstoff-antrieb/ausland/spritpreise-ausland/)
	Municipality-level variables	
LBT	*LBT* is the local business tax rate.	Federal Statistical Office of Germany (https://www.destatis.de/DE/Themen/Staat/Steuern/Steuereinnahmen/_inhalt.html#sprg245508)
Cars	*Cars* is the number of registered cars per municipality.	Federal Motor Transport Authority (https://www.kba.de/DE/Statistik/statistik_node.html)
StationsPerCar	*StationsPerCar* represents the natural logarithm of the number of gas stations over the number of registered cars per municipality.	Own calculation with other data retrieved
UnemploymentRate	*Unemployment rate* is the natural logarithm of the lagged rate of unemployment per municipality.	Federal Agency of Labor (https://statistik.arbeitsagentur.de)

Figure 1: Distribution of local business tax changes

This figure shows the numbers of local business tax hikes (Panel A) and cuts (Panel B) larger than 0.25 percentage point and 1 percentage point.

Panel A: Increases of the local business tax **Panel B: Decreases of the local business tax**

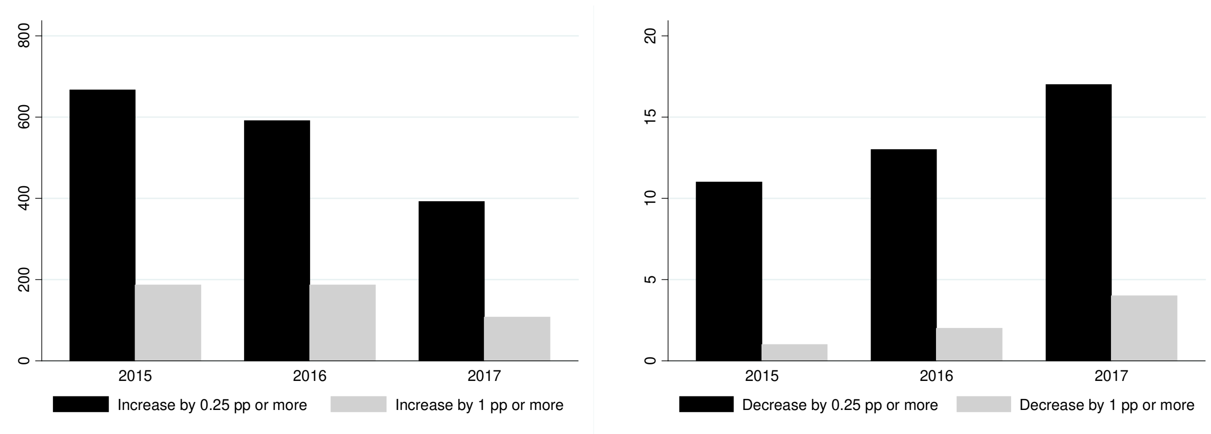


Figure 2: Local business tax in Germany

This figure depicts the local business tax landscape in Germany. Panel A presents the distribution of local business tax in Germany, where we split municipalities into quintiles. In Panel B, we depict whether a municipality has experienced one or multiple changes in local business tax rates over our sample period.

Panel A: Local business tax quintiles **Panel B: Changes in local business tax**

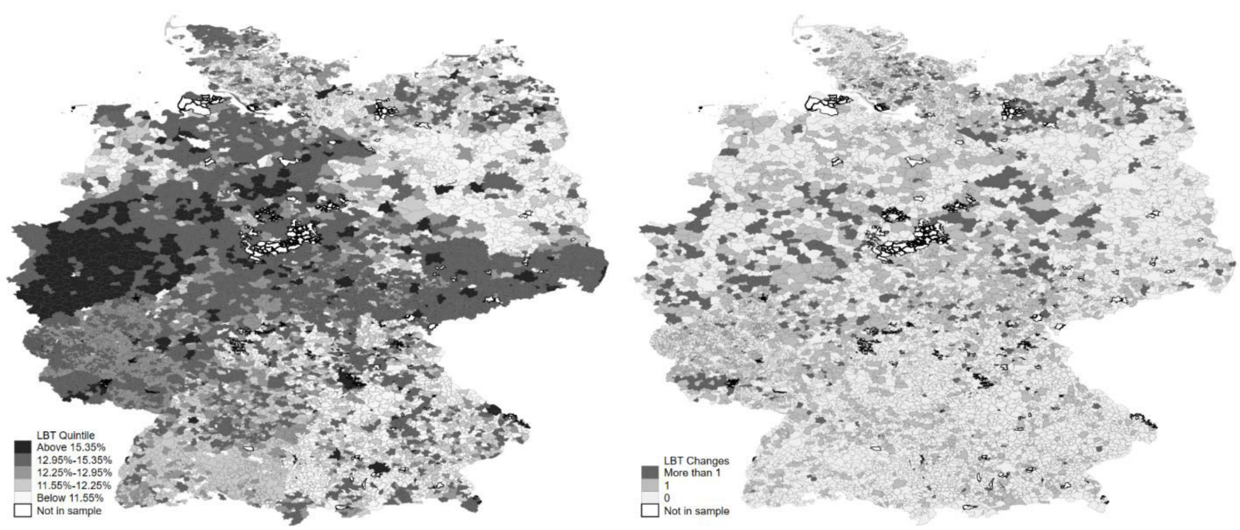


Figure 3: Distribution of gas prices

This figure depicts the distribution of gas prices after clearing and winsorizing the data set. Panel A uses the observations for all the years. In Panel B, we present the distributions for each sample year.

Panel A: Distribution, 2014–2017 **Panel B: Distributions by year**

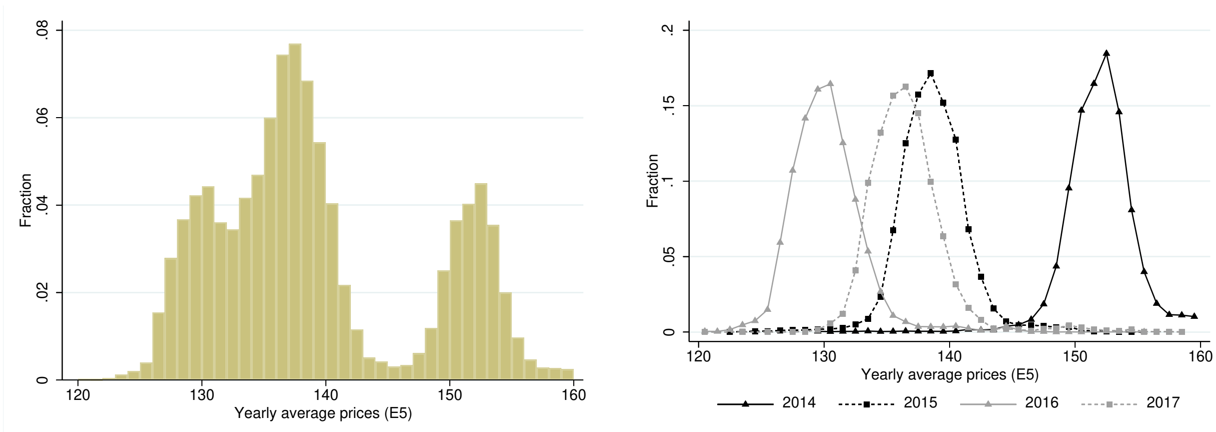


Figure 4: Daily variation in gas prices

This figure depicts the E5 price differences from the demeaned average price per liter (in euro cents). We demean the daily price at the district level.

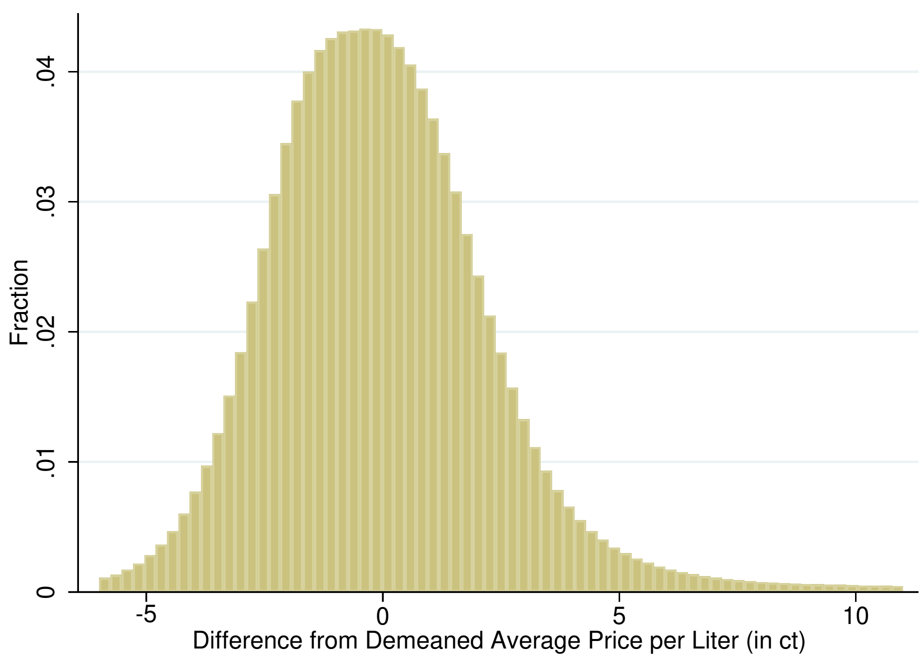
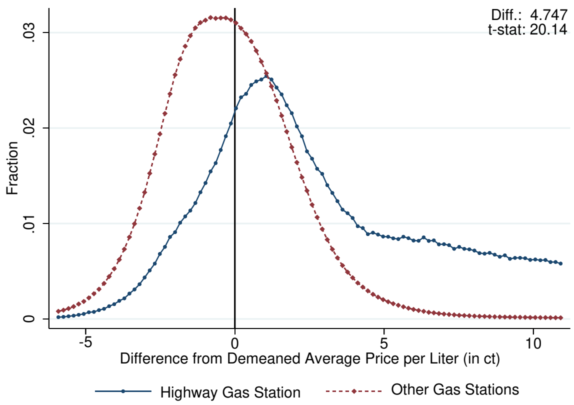


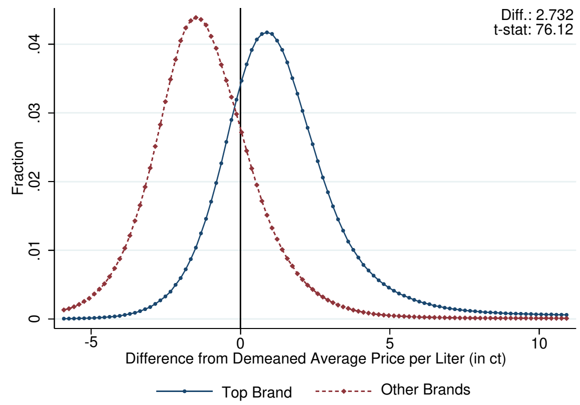
Figure 5: Daily variation in gas prices and breakdown by demand elasticity

This figure depicts the E5 price differences from the demeaned average price per liter (in euro cents). We demean the daily price at the district level. Panel A shows the differences for highway gas stations versus other gas stations, and Panel B shows the differences between top brand and other branded gas stations. Panel C compares gas stations that are always open (24/7 gas stations) to all the other gas stations. Differences in average demeaned prices and the t-statistics of the differences (based on clustered standard errors at the day–district level) are reported in each panel.

Panel A: Highway gas stations



Panel B: Top brand gas stations



Panel C: 24/7 gas stations

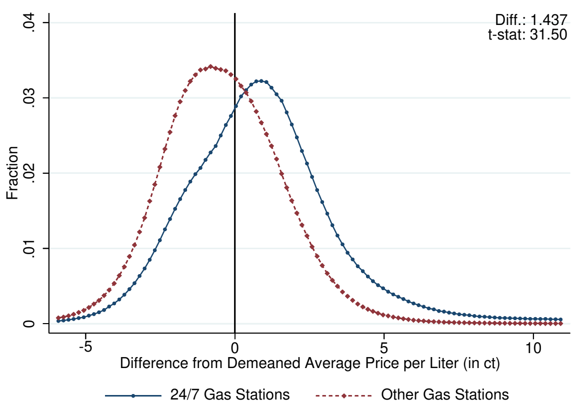


Table 1. Descriptive statistics

This table presents descriptive statistics for the main variables. Panel A shows the descriptive statistics for the sample selection with 4,507 municipalities and 15,111 gas stations.

Variable	Mean	Standard deviation	25th percentile	Median	75th percentile
E5 (in euro cents)	139	8.42	133	137	145
E10 (in euro cents)	137	7.73	131	135	142
Diesel (in euro cents)	118	9.43	112	116	124
Local business tax rate (in %)	13.85	1.87	12.25	13.65	15.40
Affected	0.69	0.46	0	1	1
Unincorporated	0.47	0.50	0	0	1
Incorporated	0.07	0.25	0	0	0
Highway	0.03	0.18	0	0	0
Top Brand	0.41	0.49	0	0	1
24/7	0.31	0.46	0	0	1
Cars	94,558	236,074	6,291	16,211	51,709
Cars (log)	9.90	1.69	8.75	9.69	10.85
Stations Per Car	0.0016	0.0021	0.0010	0.0012	0.0017
UnemploymentRate	0.03	0.02	0.02	0.03	0.04
UnemploymentRate (log)	-3.55	0.50	-3.91	-3.56	-3.15
Very Close	0.25	0.43	0	0	1
High Competition	0.14	0.35	0	0	1
High Price Abroad	0.08	0.27	0	0	0

Table 2. Local business tax and E5: Main regression results

This table presents the main regression results from regressing the local business tax rate on the level and logarithm of E5 fuel prices. Controls are included in columns (3) and (4). We include gas station and state–year fixed effects in Panel A, gas station and district–year fixed effects in Panel B, and a change specification in Panel C. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Main regression results, with state–year fixed effects				
	Without controls		**Including controls**	
	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)
LBT	0.1182**	0.0008**	0.1163**	0.0008**
	(0.0502)	(0.0004)	(0.0503)	(0.0004)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
State–Year FE	Yes	Yes	Yes	Yes
Observations	56,395	56,395	56,395	56,395
Adj. within R^2	0.0004	0.0004	0.0008	0.0008
Adjusted R^2	0.9677	0.9669	0.9677	0.9670
Panel B: Main regression results, with district–year fixed effects				
	Without controls		**Including controls**	
	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)
LBT	0.1083**	0.0008**	0.1078**	0.0008**
	(0.0439)	(0.0003)	(0.0439)	(0.0003)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	56,395	56,395	56,395	56,395
Adj. within R^2	0.0003	0.0003	0.0004	0.0004
Adjusted R^2	0.9713	0.9708	0.9713	0.9708
Panel C: Change Specification (with district–year FE)				
	Without controls		**Including controls**	
	ΔE5	ΔE5 (log)	ΔE5	ΔE5 (log)
	(1)	(2)	(3)	(4)
Δ LBT	0.0980***	0.0007***	0.0981***	0.0007***
	(0.0337)	(0.0002)	(0.0336)	(0.0002)
Controls	No	No	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	41,421	41,421	41,421	41,421
Adj. within R^2	0.0002	0.0002	0.0002	0.0002
Adjusted R^2	0.9658	0.9654	0.9658	0.9654

Table 3. Local business tax and E5 prices: Lead analysis

This table presents the main regression results, including lead values for changes in the local business tax rate. All the variables are defined in first differences. Columns (1) and (2) do not include controls variables, whereas columns (3) and (4) do. We include district–year fixed effects in all the specifications. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Without controls		**With controls**	
	ΔE5	ΔE5 (log)	ΔE5	ΔE5 (log)
	(1)	(2)	(3)	(4)
Δ LBT	**0.1599*** **	**0.0011*** **	**0.1593*** **	**0.0011*** **
	(0.0597)	**(0.0004)**	**(0.0596)**	**(0.0004)**
Δ LBT_{t+1}	0.0135	0.0001	0.0132	0.0001
	(0.0951)	(0.0007)	(0.0954)	(0.0007)
Δ LBT_{t+2}	0.0907	0.0006	0.0875	0.0006
	(0.1143)	(0.0008)	(0.1145)	(0.0008)
Controls	No	No	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	13,205	13,205	13,205	13,205
Adj. within R^2	0.0003	0.0003	0.0004	0.0003
Adjusted R^2	0.1021	0.1021	0.1021	0.1021

Table 4. Local business tax and E5 prices: Identification

This table presents the identification strategy around the critical local business tax rate of 13.3% for unincorporated companies. We include gas station and organizational form–district–year fixed effects. Panel A presents the regressions results for treated gas stations (unincorporated firms facing a local business tax rate above 13.3% and any incorporated firms) versus unaffected gas stations. Panel B shows a detailed breakdown of the separate groups. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Treated versus untreated gas stations

	Without controls		**With controls**	
	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)
LBT	-0.0350	-0.0003	-0.0337	-0.0003
	(0.0873)	(0.0006)	(0.0871)	(0.0006)
LBT × Affected	0.2329**	0.0018**	0.2285**	0.0017**
	(0.1061)	(0.0007)	(0.1062)	(0.0007)
Joint significance test:	*0.1979****	*0.0014****	*0.1948****	*0.0014****
LBT + LBT × Affected	*(0.0623)*	*(0.0004)*	*(0.0623)*	*(0.0004)*
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	31,129	31,129	31,129	31,129
Adj. within R^2	0.0006	0.0006	0.0008	0.0008
Adjusted R^2	0.9763	0.9757	0.9763	0.9757

Panel B: Treated versus untreated gas stations, detailed breakdown, E5

	Unincorporated gas stations		**Incorporated gas stations**	
	LBT < 13.3%	*LBT* > 13.3%	*LBT* < 13.3%	*LBT* > 13.3%
N	(N = 9,526)	(N = 17,777)	(N = 1,340)	(N = 2,053)
	(1)	(2)	(3)	(4)
LBT	**-0.0748**	**0.2765*****	**0.4120****	**0.2961**
	(0.0929)	**(0.0720)**	**(0.1721)**	**(0.1813)**
Difference between Col. (1)		*0.3513****	*0.4868***	*0.3709**
and Col. (2)/(3)/(4)		*(0.1177)*	*(0.1919)*	*(0.2028)*
Difference between Col. (2)			*0.1355*	*0.0196*
and Col. (3)/(4)			*(0.1856)*	*(0.1940)*
Difference between Col. (3)				*-0.1159*
and Col. (4)				*(0.2346)*
Controls		Yes		
Gas Station FE		Yes		
Org. Form–District Year FE		Yes		
Observations		30,696		
Adj. within R^2		0.0016		
Adjusted R^2		0.9764		

Panel C: Treated versus untreated gas stations, detailed breakdown, E5 (log)				
	Unincorporated gas stations		**Incorporated gas stations**	
	LBT < 13.3%	*LBT* > 13.3%	*LBT* < 13.3%	*LBT* > 13.3%
N	(N = 9,526)	(N = 17,777)	(N = 1,340)	(N = 2,053)
	(1)	(2)	(3)	(4)
LBT	**-0.0006**	**0. 0019*****	**0.0029****	**0.0021**
	(0.0007)	**(0.0005)**	**(0.0012)**	**(0.0013)**
Difference between Col. (1)		*0.0025****	*0.0035***	*0.0026**
and Col. (2)/(3)/(4)		*(0.0008)*	*(0.0014)*	*(0.0014)*
Difference between Col. (2)			*0.0010*	*0.0002*
and Col. (3)/(4)			*(0.0013)*	*(0.0013)*
Difference between Col. (3)				*-0.0008*
and Col. (4)				*(0.0016)*
Controls			Yes	
Gas Station FE			Yes	
Org. Form–District Year FE			Yes	
Observations			30,696	
Adj. within R^2			0.0016	
Adjusted R^2			0.9757	

Table 5. Local business tax, consumer demand elasticity, and gas prices

This table presents the results of cross-sectional analyses regarding the regression of the local business tax rate on the level and logarithm of E5 fuel prices. In columns (1) and (2), we interact *LBT* with *Highway*, which is a dummy variable equal to one if a gas station is located in immediate proximity to a highway. In columns (3) and (4), we interact *LBT* with *Top Brand*, which is a dummy variable equal to one if the gas station belongs to the brands Aral, Esso, Shell, or Total, the most well-known brands in Germany. In columns (5) and (6), we interact *LBT* with *24/7*, which is a dummy variable equal to one if a gas station's regular opening hours are 24 hours each day. We include gas station and district–year fixed effects. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	E5	E5 (log)	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)	(5)	(6)
LBT × Highway	1.3546***	0.0109***				
	(0.2884)	(0.0021)				
LBT × Top Brand			0.5459***	0.0052***		
			(0.0728)	(0.0005)		
LBT × 24/7					0.4549***	0.0038***
					(0.0741)	(0.0005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes	Yes	Yes
Mun.–Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	48,161	48,161	48,161	48,161	38,421	38,421
Adj. within R^2	0.0032	0.0041	0.0036	0.0063	0.0025	0.0036
Adj. R^2	0.9748	0.9743	0.9748	0.9744	0.9780	0.9774

Table 6. Local business tax, demand elasticity, and gas prices: Local competition

This table presents the results of cross-sectional analyses regarding the regression of the local business tax rate on the logarithm and level of E5 fuel prices. We interact *LBT* with *High Competition*, which is a dummy equal to one if the municipality is characterized by low demand (below-median cars per inhabitant) and high supply (above-median gas stations per inhabitant). The combination of low demand and high supply results in high local competition. Columns (1) and (2) include the whole sample, whereas columns (3) and (4) exclude municipalities with low competition (i.e., with above-median demand and below-median supply). We include gas station and district–year fixed effects. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Full sample		**Sample excluding municipalities with low competition**	
	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)
LBT	0.1531***	0.0011***	0.1426***	0.0010***
	(0.0476)	(0.0003)	(0.0543)	(0.0004)
LBT × High Competition	-0.1862**	-0.0013**	-0.1470*	-0.0011*
	(0.0762)	(0.0006)	(0.0795)	(0.0006)
Controls	Yes	Yes	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	No	No
Observations	56,395	56,395	47,990	47,990
Adj. within R^2	0.0008	0.0008	0.0010	0.0009
Adj. R^2	0.9710	0.9710	0.9710	0.9710

Table 7. Local business tax and gas prices: Evidence of coordination

This table presents the results of cross-sectional analyses regarding the regression of the local business tax rate on the level and logarithm of E5 fuel prices. We interact *LBT* with *Very Close*, which is a dummy variable equal to one if there is another gas station in immediate proximity to the respective gas station. Columns (1) and (2) include district–year fixed effects, whereas columns (3) and (4) include municipality–year fixed effects. We include gas station and district–year fixed effects. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	District–year fixed effects		**Municipality–year fixed effects**	
	E5	E5 (log)	E5	E5 (log)
	(1)	(2)	(3)	(4)
LBT × Very Close	0.2783***	0.0021***	0.2243**	0.0017**
	(0.0840)	(0.0006)	(0.0945)	(0.0007)
Controls	Yes	Yes	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	No	No
Municipality–Year FE	No	No	Yes	Yes
Observations	48,842	48,842	48,161	48,161
Adj. within R^2	0.0019	0.0023	0.0003	0.0003
Adj. R^2	0.9722	0.9717	0.9747	0.9742

Table 8. Local business tax, demand elasticity, and gas prices: Neighboring countries

This table presents the results of cross-sectional analyses regarding the regression of the local business tax rate on the level and logarithm of E5 fuel prices, exploiting cross-country differences in gas prices. In columns (1) and (2) we interact *LBT* with *High Price Abroad*, which is a dummy variable equal to one if the district shares a border with Belgium, Denmark, France, the Netherlands, or Switzerland, and zero if the district shares a border with Austria, the Czech Republic, Luxembourg, or Poland. Districts without a border are excluded from this test. We include gas station and year fixed effects. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	E5	E5 (log)
	(1)	(2)
LBT	-0.3298	-0.0023
	(0.2298)	(0.0016)
LBT × High Price Abroad	0.8070***	0.0057***
	(0.2729)	(0.0019)
Joint significance test:	*0.4772****	*0.0034****
LBT + LBT × High Price Abroad	*(0.1688)*	*(0.0012)*
Controls	Yes	Yes
Gas Station FE	Yes	Yes
Year FE	Yes	Yes
Observations	6,576	6,576
Adj. within R^2	0.0065	0.0069
Adjusted R^2	0.9579	0.9576

Table 9. Local business tax, demand elasticity, and gas prices: Product characteristics

This table presents the results of cross-sectional analyses regarding the comparison of diesel versus E5 prices. The dependent variable is either the Diesel price or the E5 price in level (columns (1) and (3)) and in logarithm (columns (2) and (4)), respectively. We interact *LBT* with *E5*, which is a dummy variable equal to one for the E5 price. Columns (1) and (2) include gas station fixed effects, whereas columns (3) and (4) include gas station–year fixed effects. We municipality–year fixed effects in all columns. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Gas station fixed effects		**Gas station–year fixed effects**	
	Price	Price (log)	Price	Price (log)
	(1)	(2)	(3)	(4)
E5	19.6281***	0.1479***	19.6167***	0.1478***
	(0.1544)	(0.0015)	(0.1548)	(0.0015)
LBT × E5	0.0999***	0.0012***	0.1000***	0.0012***
	(0.0120)	(0.0001)	(0.0120)	(0.0001)
Controls	Yes	Yes	Yes	Yes
Gas Station FE	Yes	Yes	No	No
Gas Station-Year FE	No	No	Yes	Yes
Municipality–Year FE	Yes	Yes	Yes	Yes
Observations	114,573	114,573	113,474	113,474
Adj. within R^2	0.987	0.977	0.994	0.984
Adj. R^2	0.990	0.981	0.990	0.972

Online Appendix

Part I. Dynamics of gas prices: Top brand gas stations versus other gas stations

In this part of the Online Appendix, we present evidence of two features that characterize the dynamics of gas prices in Germany. First, we show that top brands (Aral, Shell, Esso, Total, and Avia) set prices centrally for all gas stations within a region. To document this empirically, we use the data of all gas price changes in five-minute intervals, yielding about 150 million observations during our sample period. We then plot the number of a brand's gas stations in a district on the x-axis and the average number of that brand's gas stations that changed their gas price within the same district on the y-axis over all events (i.e., that company's gas price changes). That is, the number 8 on the x-axis indicates that a given brand has eight gas stations in the district. The number 2 on the y-axis indicates that, conditional on a price change, the brand simultaneously changes the gas price at two of its eight gas stations in this district. Figure A.1 plots the results for the top brands versus the other gas stations. The results are consistent with centralized pricing. For example, within a five-minute window, top brand gas stations simultaneously change their prices in almost three gas stations, whereas all the other gas stations, on average, experience a simultaneous change in only 1.3 gas stations if the respective brand has eight gas stations.

To express this point alternatively, we calculate the percentage of cases in which the respective brand simultaneously changed the gas prices of *all* its gas stations in a given district (see Figure A.2). Apparently, for non-brand gas stations, there is no evidence of any (perfect) price coordination, since there are very few cases (0.1% of all cases) in which all the gas stations in a district change their gas prices simultaneously, if there are more than two gas stations. For top brand gas stations, this is different: for example, in districts in which a top brand operates five gas stations, this top brand simultaneously changes the price of *all* five gas stations in about 5% of all price changes, consistent with regional price coordination.

Figure A.1. Simultaneous price changes within districts

This figure shows the average number of gas stations that changed their gas price within the same district on the y-axis over all events (i.e., gas price changes of this company). The x-axis is the number of gas stations operated by the respective brand in a given district. We plot the average for top brand gas stations versus the group of other gas stations (all non-top brand gas stations). We use the raw data of all gas price changes in five-minute intervals from the approximately 150 million observations during our sample period.

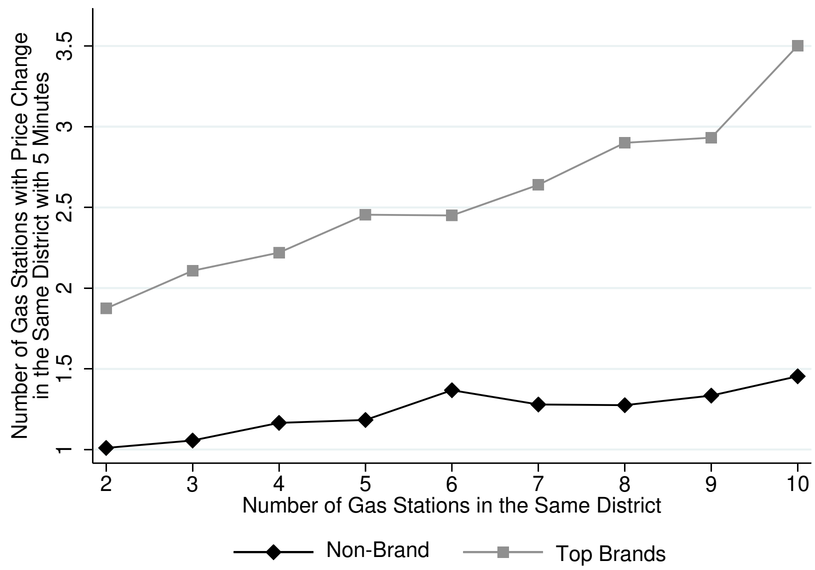
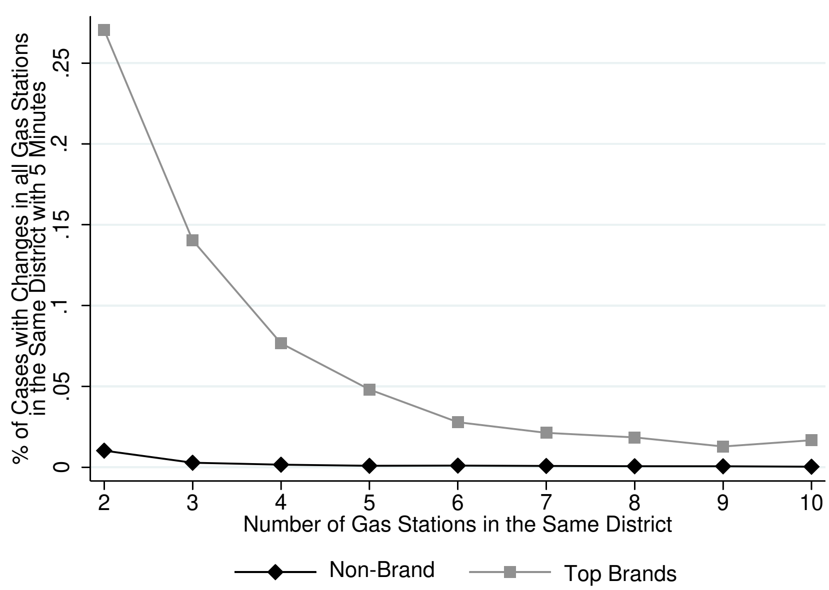


Figure A.2. Concurrent price changes in all gas stations within a district

This figure shows the percentage of cases in which the respective brand simultaneously changed the gas prices of all its gas stations in a given district on the y-axis. The x-axis is the number of gas stations operated by the respective brand in a given district. Panel A plots the percentage for Aral versus the group of other gas stations (all non-top brand gas stations). Panels B to E replicate this test comparing Shell, Esso, Total, and Avia, respectively, against the other gas stations. We use the raw data of all gas price changes in five-minute intervals from the approximately 150 million observations during our sample period.



In the second step, we show that the gas stations of other brands follow the prices changes of the top brand gas stations. Based on the price change data, we create a panel of gas prices for 15-minute intervals for the years 2014 to 2017. This results theoretically in about 520 million observations (= 14,916 gas stations × 365 days × 24 hours × 4 blocks of 15 minutes) for one year. From this, we draw a 10% random sample of gas stations, that is, about 50 million observations for an individual year. We then calculate the district-specific average gas price change (as a natural logarithm) over a 15-minute period separately for top brand gas stations and non-top brand gas stations. In the final step, we regress the gas station's change in E5 (as a natural logarithm) on eight lags of the average price change of the top brand gas stations and on eight lags of the average price change of non-top brand gas stations in the same district. The regression includes district–day fixed effects.

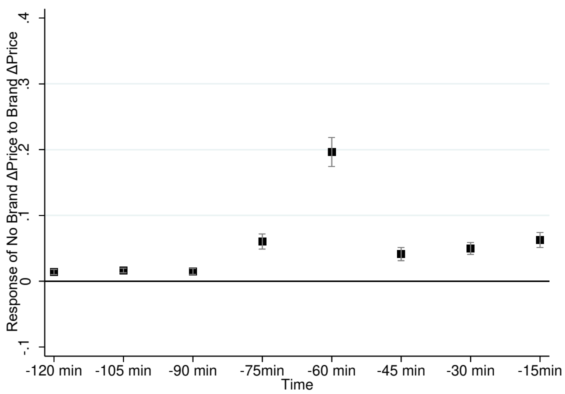
In Figure A.3, Panel A, we plot the coefficient estimates for the eight lags of the average price change of top brand gas stations in the same district, using the sample of non-top brand gas stations. The coefficient estimate suggests an economically significant correlation of non-top brand gas station price changes with the fourth lag of the average price change of top brand gas stations in a district. Given that one lag represents 15 minutes, there appears to be a delay in the price change of non-top brand gas stations of about an hour following a price change of top brand gas stations. In contrast, when estimating the opposite relation—the correlation of price changes of a top brand gas station with the average price change of non-top brand gas stations in the same district—the correlation is very small, indicating that top brand gas stations lead price changes in a district.

Figure A.3. Price dynamics between top brand and non-top brand gas stations

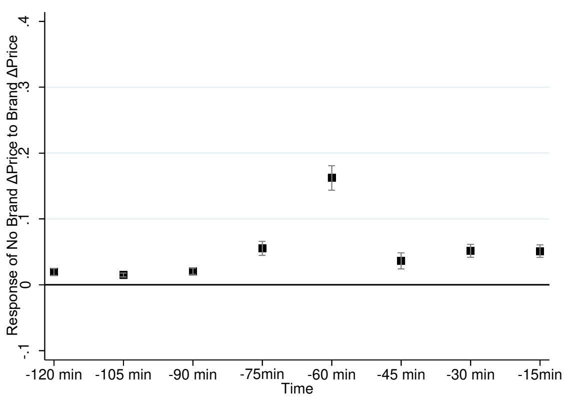
This figure plots the coefficients from a regression of the change in E5 (as a natural logarithm) on average price changes in the same district. The regression is estimated at the gas station level, using a panel of gas station prices for the years 2014 to 2017 and gas prices defined in 15-minute intervals. The regression includes gas station and district–day fixed effects. The independent variables are eight lags of the average price changes of top brand gas stations, as well as eight lags of the average price changes of non-top brand gas stations. Panel A uses the sample of non-top brand gas price changes and reports eight lags of the average price changes of top brand gas stations. Panel B uses the sample of top brand gas price changes and reports eight lags of the average price changes of non-top brand gas stations. We use a 10% random sample of gas stations, yielding about 50 million observations. Standard errors are clustered at the gas station level.

Panel A: Non-brand prices, firm level

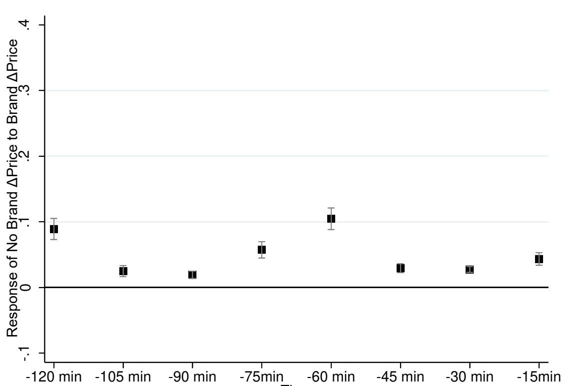
2017



2016

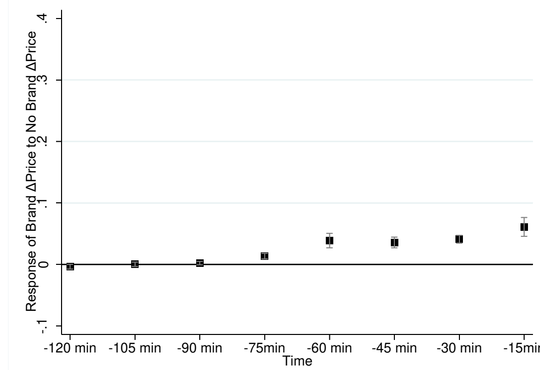


2015

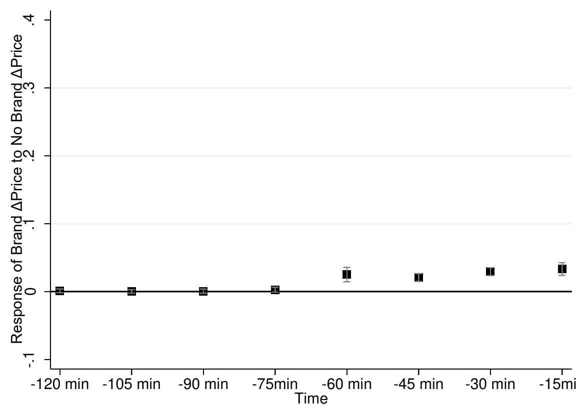


Panel B: Brand prices, firm level

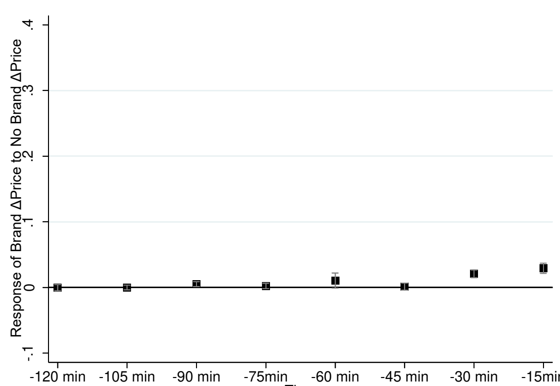
2017



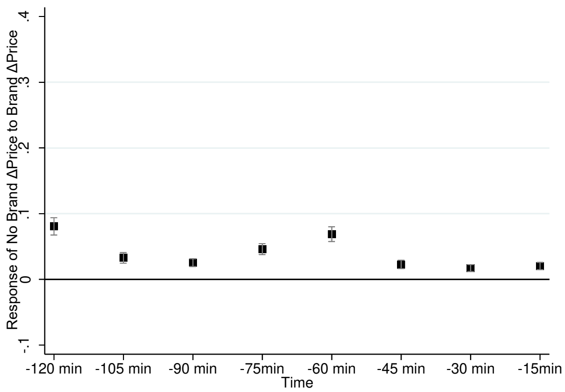
2016



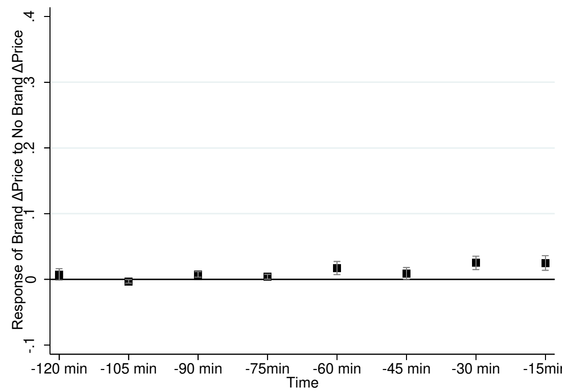
2015



2014


Response of No Brand ΔPrice to Brand ΔPrice
.4
.3
.2
.1
0
-.1
-120 min
-105 min
-90 min
-75min
-60 min
-45 min
-30 min
-15min
Time

2014


Response of Brand ΔPrice to No Brand ΔPrice
.4
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-105 min
-90 min
-75min
-60 min
-45 min
-30 min
-15min
Time

Part II. Additional tables

Table A.1. Local business tax and E10 prices: Main regression results

This table presents the main regression results on gas prices. This table replicates Table 2, but uses the level and logarithm of E10 fuel prices as the dependent variables. The main independent variable is *LBT*, the local business tax rate. Controls are included in columns (3) and (4). We include gas station and state–year fixed effects in Panel A, and gas station and district–year fixed effects in Panel B. We use a first-difference model in Panel C. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Main regression results with state–year fixed effects				
	Without controls		**With controls**	
	E10	E10 (log)	E10	E10 (log)
	(1)	(2)	(3)	(4)
LBT	0.1175**	0.0009**	0.1160**	0.0008**
	(0.0570)	(0.0004)	(0.0570)	(0.0004)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
State–Year FE	Yes	Yes	Yes	Yes
Observations	54,809	54,809	54,809	54,809
Adj. within R^2	0.0004	0.0004	0.0007	0.0007
Adjusted R^2	0.9569	0.9572	0.9569	0.9572
Panel B: Main regression results with district–year fixed effects				
	Without controls		**With controls**	
	E10	E10 (log)	E10	E10 (log)
	(1)	(2)	(3)	(4)
LBT	0.0852	0.0007*	0.0850	0.0007*
	(0.0537)	(0.0004)	(0.0537)	(0.0004)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	54,809	54,809	54,809	54,809
Adj. within R^2	0.0002	0.0002	0.0002	0.0004
Adjusted R^2	0.9614	0.9620	0.9614	0.9620
Panel C: Change specification				
	Without controls		**With controls**	
	ΔE10	ΔE10 (log)	ΔE10	ΔE10 (log)
	(1)	(2)	(3)	(4)
Δ LBT	0.0674	0.0005	0.0675	0.0005
	(0.0555)	(0.0004)	(0.0555)	(0.0004)
Controls	No	No	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	40,793	40,793	40,793	40,793
Adj. within R^2	0.0001	0.0001	0.0001	0.0001
Adjusted R^2	0.9493	0.9517	0.9493	0.9517

Table A.2. Local business tax and diesel prices: Main regression results

This table presents the main regression results on gas prices. This table replicates Table 2, but uses the level and logarithm of the diesel price as dependent variables. The main independent variable is *LBT*, the local business tax rate. Controls are included in columns (3) and (4). We include gas station and state–year fixed effects in Panel A, and gas station and district–year fixed effects in Panel B. We use a first-difference model in Panel C. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Main regression results with state–year fixed effects

	Without controls		**With controls**	
	Diesel	Diesel (log)	Diesel	Diesel (log)
	(1)	(2)	(3)	(4)
LBT	0.1211**	0.0010**	0.1109**	0.0009**
	(0.0459)	(0.0004)	(0.0459)	(0.0004)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
State–Year FE	Yes	Yes	Yes	Yes
Observations	57,738	57,738	57,738	57,738
Adj. within R^2	0.0004	0.0004	0.0006	0.0006
Adjusted R^2	0.9784	0.9766	0.9784	0.9766

Panel B: Main regression results with district–year fixed effects

	Without controls		**With controls**	
	Diesel	Diesel (log)	Diesel	Diesel (log)
	(1)	(2)	(3)	(4)
LBT	0.0881**	0.0008**	0.0878**	0.0008**
	(0.0398)	(0.0003)	(0.0398)	(0.0003)
Controls	No	No	Yes	Yes
Gas Station FE	Yes	Yes	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	57,738	57,738	57,738	57,738
Adj. within R^2	0.0002	0.0002	0.0003	0.0003
Adjusted R^2	0.9810	0.9795	0.9810	0.9795

Panel C: Change specification

	Without controls		**With controls**	
	ΔDiesel	ΔDiesel (log)	ΔDiesel	ΔDiesel (log)
	(1)	(2)	(3)	(4)
Δ LBT	0.0694**	0.0006**	0.0694**	0.0006**
	(0.0344)	(0.0003)	(0.0343)	(0.0003)
Controls	No	No	Yes	Yes
District–Year FE	Yes	Yes	Yes	Yes
Observations	42,971	42,971	42,971	42,971
Adj. within R^2	0.0001	0.0001	0.0001	0.0001
Adjusted R^2	0.9768	0.9753	0.9768	0.9753

Table A.3. Additional robustness tests

This table presents the main regression results on gas prices. The dependent variable is the gas price of E5 in terms of levels (Panel A) and its natural logarithm (Panel B). The main independent variable is *LBT*, the local business tax rate. In column (1), we augment equation (1) and additionally control for local real estate tax rates. In column (2) (column (3)), we use equation (1) and additionally interact all control variables except *LBT* with year (state) dummy variables. In column (4), we use equation (1) and additionally interact all control variables except *LBT* with year dummy variables, as well as with state dummy variables. We include gas station and district–year fixed effects in all tests. We report robust standard errors clustered at the municipality level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Additional robustness tests with E5				
	E5	E5	E5	E5
	(1)	(2)	(3)	(4)
LBT	0.1158**	0.1063**	0.1113**	0.1079**
	(0.0467)	(0.0439)	(0.0437)	(0.0444)
Local Real Estate Tax Control?	Yes	No	No	No
Controls	Yes	Yes	Yes	Yes
Controls × Year Dummies	No	Yes	No	Yes
Controls × State Dummies	No	No	Yes	Yes
Gas Station & District–Year FE	Yes	Yes	Yes	Yes
Observations	56,395	56,395	56,395	56,395
Adj. within R^2	0.0004	0.0014	0.0024	0.0037
Adjusted R^2	0.9713	0.9713	0.9714	0.9714

Panel B: Additional robustness tests with E5 (log)				
	E5 (log)	E5 (log)	E5 (log)	E5 (log)
	(1)	(2)	(3)	(4)
LBT	0.0008**	0.0008**	0.0008**	0.0008**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Local Real Estate Tax Control?	Yes	No	No	No
Controls	Yes	Yes	Yes	Yes
Controls × Year Dummies	No	Yes	No	Yes
Controls × State Dummies	No	No	Yes	Yes
Gas Station & District–Year FE	Yes	Yes	Yes	Yes
Observations	56,395	56,395	56,395	56,395
Adj. within R^2	0.0004	0.0015	0.0025	0.0038
Adjusted R^2	0.9708	0.9709	0.9709	0.9709

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Contact:
Prof. Dr. Caren Sureth-Sloane
Paderborn University
Faculty of Business Administration and Economics
Department of Taxation, Accounting and Finance
Warburger Str. 100, 33098 Paderborn, Germany

trr266@mail.upb.de
www.accounting-for-transparency.de